MACMILLAN'S
TEACHING IN PRACTICE
FOR SENIORS

VOLUME FOUR

MACMILLAN'S
TEACHING IN PRACTIC
FOR SENIORS

AN ENCYCLOPAEDIA OF MODERN METHODS
OF TEACHING IN THE SENIOR SCHOOL
WRITTEN BY RECOGNISED AUTHORITIES
IN EDUCATION AND

EDITED BY
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Editor of Macmillan's *Teaching in Practice in the Junior School,*
Teaching in Practice for Infant Schools, etc.

In Eight Volumes, with a Portfolio
of 150 *Class Pictures*

VOLUME FOUR

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FOUNDATIONS OF DRAWING

This article, which begins on page 483, consists of a series of forty talks, illustrated by full-page plates, on the fundamentals that should be observed in the teaching of drawing to children. The article is additional to the *Three Years' Course of Drawing* in Volume V.

PRINCIPAL CONTENTS OF THE EIGHT VOLUMES

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Art and Craft (continued).—Gardening for the School and Home; A Three Years' Course of Needlework; The Mothercraft Course of Needlework; Handicraft in Science; Repairs in the Home; The Foundations of Drawing.

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VOLUME VIII

Time-tables; The Teaching of Mathematics; The Treatment of the Backward Child; The Leavers' Class and Vocational Guidance; Getting a First Job; The House and Team System; The School Camp and London Journey; The Care of Pets.

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GARDENING FOR THE SCHOOL AND HOME

All Teachers interested in Gardening, whether at Home or at School will find this Article very helpful as a Guide to the Successful Cultivation of Vegetables, Flowers, and Fruit. There is a Woodwork Section for Garden Equipment in Vol. III.

[Reproduced by courtesy of "The Country Life Picture Book of Britain"

THE KING'S DAFFODILS

Sandringham, His Majesty's country house in Norfolk, is famous for its gardens which can be visited by the public on certain days. The estate was bought in 1862 by the Prince Consort for Prince Edward and Princess Alexandra of Wales, and during the following nine years the old house was pulled down and the present one built.

INTRODUCTION AND SYLLABUS

THE past few years have witnessed an increased interest in gardening, doubtless due to the fact that the thousands of houses, with gardens attached thereto, erected since the Great War, have presented an opportunity of satisfying man's primeval instinct, which constantly leads him to Nature. Gardening has entered into the curriculum of most schools, and when the subject is systematically taught, it proves all-absorbing as well as highly educational.

In senior schools there should be a three-year syllabus, thus making sure that throughout his tenure the pupil is always in receipt of some gardening teaching. The object in these pages is to help the teacher as much as possible, and also to assist those teachers who outside school hours find in gardening a pleasant hobby and recreation. The syllabus is given first, as that is the basis on which everything rests.

FIRST YEAR SYLLABUS

Soils.—Origin, types, digging, mock trenching, trenching.

Manures.—Organic and inorganic, examples of each, their effect on the texture of the soil, function, method of application.

Lime.—Function, kinds of lime, method of application.

Tools.—Uses and care.

Vegetable production.—The cultivation of root crops; e.g., potatoes, carrots, onions, parsnips, beetroot, and turnips; brassicas; e.g., cabbages, cauliflowers, Brussels sprouts, savoys, kale, and colewort; pod-bearing crops; e.g., broad beans, French beans, runner beans and peas; salads, celery, and leeks; vegetable marrows.

Experimental work.

SECOND YEAR SYLLABUS

Propagation.—Seed sowing, stem and root cuttings, layering, budding, grafting.

Insect pests.—The life history of an insect showing complete metamorphosis and incomplete metamorphosis respectively; examples of the principal vegetable, flower, and fruit pests, together with approved methods of control.

Fungoid diseases.—The life history of a typical fungus, examples of the principal fungoid diseases of vegetables, flowers and fruit.

Flower cultivation.—Hardy annuals, hardy biennials, hardy perennials, roses and ornamental shrubs.

Lawns and lawn management.—Sowing, turfing, rolling, mowing, fertilising.

Rockery.—Construction, cultivation of Alpines.

Experimental work.

THIRD YEAR SYLLABUS

Glass structures.—The cool greenhouse, cold frame, cloches, their uses and management.

Fruit cultivation.—Apples, pears, plums, cherries; standard, bush, and cordon trees; red and black currants, gooseberries, raspberries, loganberries, blackberries and strawberries; soil preparation, planting, pruning, spraying, gathering, storage, varieties.

Experimental work.

SALIENT FEATURES OF SYLLABUS.

It will be observed that during the first year attention is concentrated on vegetables, in the second on flowers, in the third on under-glass work and fruit. Much experience of various methods of approaching the subject proves that this is probably the best. Confusion results when an attempt is made to deal with the three sections simultaneously. The child's mind is not able to absorb all at once. Essential horticultural principles are taught each year also, ensuring a comprehensive knowledge of the subject at the end of the three-year period.

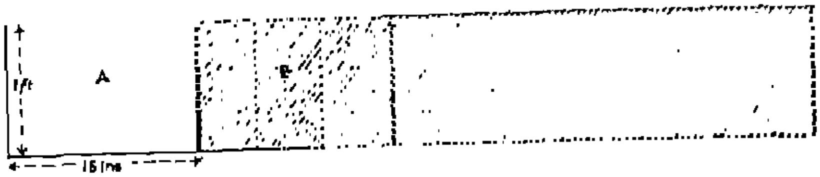


Fig. 3. Diagram showing Trench Arrangement for Digging or Working the Soil, 1 ft. deep

A. First trench.
B. Move to A.

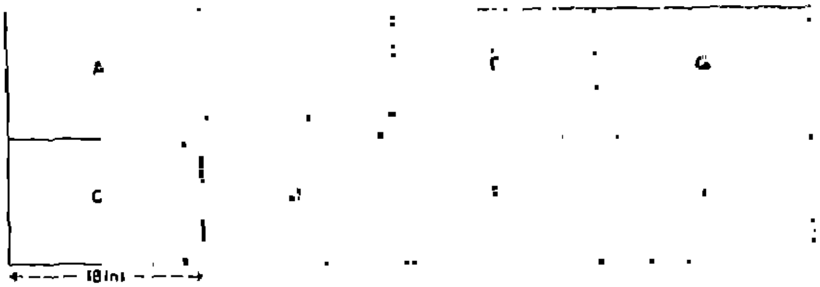


Fig. 4. Diagram showing Trench Arrangement for Mock Trenching or Working the Soil, 2 ft. deep, without Changing the Position of the 1 ft. Layers

A, B, C. First formed trenches.
Move D to C.
Move E to A.
Move F to D.
Move G to B.
Move H to F.

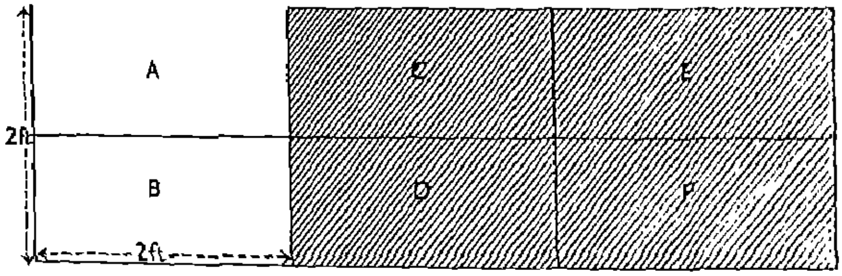


Fig. 5. Diagram showing Arrangement for Trenching or Working the Soil, 2 ft. deep, Reversing the Position of the 1 ft. Layers

A, B. First formed trench.
Move C to B.
Move D to A.
Move E to D.
Move F to C.

takes precedence because it is rich in plant food and humus too. Other organic manures are spent hops, leaf mould, and decaying vegetable refuse. Their food content is low, their humus content high. Each can, however, be made an efficient substitute by raking into the soil, immediately before planting or sowing, a 2 oz. per square yard dressing of 4 parts superphosphate of lime and 1 part each of sulphate of ammonia and sulphate of potash. There are proprietary organic manures made synthetically. Many of them are so good that they have earned the encomiums, never given without careful thought and experiment, of the authorities at the research stations.

The application of organic manures.—Autumn, winter, and early spring are the main seasons for the application of organic manures. It is then that most plantings and crop preparations proceed. The rate of application varies in accordance with the subject to be sown or planted. Details are given in the appropriate places in later chapters. The method of application consists, when digging, mock trenching, or trenching, of spreading the manure at the bottom of the trenches, and covering it with a spit of soil. Later the manure is intimately mixed with the particles. When preparing to plant, the manure is always mixed, as a solid layer would be injurious to any root which had the misfortune to encounter it, Fig. 6.

Inorganic manures.—Inorganic manures are generally of mineral origin. They increase the soil food supply, but when used alone have a disastrous effect on its texture, so disastrous, indeed, that any sort of cultivation is impossible. The reason is that artificial manures contain no humus. Seeing that they might injure, the natural question is, why use artificial manures at all? The answer is that when applied in conjunction with organic manures, the adverse effect on texture is counterbalanced. The food supply is extremely valuable, because by consulting the analysis which must, under the *Fertilisers and Feeding Stuffs Act*, be supplied with each sample, it is possible to give the plant just what it needs.

The action of inorganic manures.—The three elements the gardener adds when applying a complete manure are nitrogen, phosphates, and potash, all in some form of combination. Nitrogen assists leaf growth. Thus when fruit, flowers, or vegetables need a leaf stimulant, the gardener turns to nitrogenous fertilisers such as nitrate of soda, sulphate of ammonia, and nitrate of ammonia. Phosphates increase root action and assist the development of reproductive organs. The fertilisers in this group are used, therefore, to benefit plants at both ends of their life. Fertilisers in the group are basic slag, bone meal, steamed bone flour, phosphatic guano, and superphosphate of lime. Potash is the transport agent. Since all foods are manufactured in the leaves, it follows that there must be some agent to transport them to the seats of growth and reserve. Potash fulfils that function, hence its value

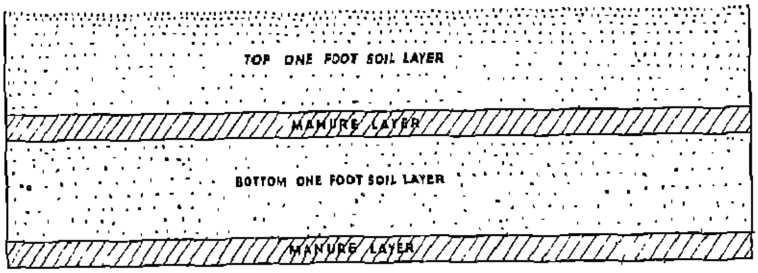


FIG. 6. DIAGRAM SHOWING POSITION IN WHICH MANURE SHOULD BE PLACED WHEN DIGGING, MOCK TRENCHING OR TRENCHING

to all plants, especially fruit and root vegetables, which have large storage and reserve organs. Kainit, muriate of potash, and sulphate of potash are the principal forms of potash manures.

How to apply inorganic manures.—Every teacher and every gardener should assimilate these points thoroughly. Unless he knows that artificial manures may be dangerous, and why, and also that they may be very valuable helpers, and how and why, his teaching and practice will fall short of the best. There are well defined application rules. For instance, artificial manures must never assume contact with roots, stems, or leaves, which they scald or plasmolyse. Being concentrated, they must be used in small quantities. "Little and often" is an excellent rule. When applied to vacant land, they should be raked in after digging. Their natural tendency is to sink, hence the need to keep them in the upper layer. They must be dissolved in the soil water. As dry salts they are useless. That is the reason why when artificials are applied to a growing crop, they are hoed in if the soil is moist, and watered in if it is dry. Since water alters the composition, these manures, when bought some time before use, should be stored in a dry place. They lose value and become difficult to handle after being wetted.

Lime and liming.—Calcium, or lime, is not a plant food as generally understood. It enters into the composition of plants, but not on the nutritional side. Its great function is that of sweetening the soil, and restraining the attack of fungoid diseases and insect pests. Plant roots and manures are continually discharging acids. Unless some corrective were introduced, land would in course of time become so sour that nothing could be successfully grown in it. Many hundreds of acres of land in the country are in this condition to-day. They need lime. Fungi flourish in acidity also, and it is well known that when lime is consistently used such serious soil insect pests as wireworms and leatherjackets are far less prevalent.

The liming programme.—To maintain the correct degree of soil sweetness, it is essential to apply lime once in three years, a convenient way being to divide the area into three equal portions, and treat one each year. Make the application any time between early October and early February. Do not use stable manure at the same time. When the two substances assume contact, they cancel out each other's good qualities. The lime combines with the nitrogenous compound in the manure, ultimately releasing the ammonia as gas. In doing so it sacrifices its own alkalinity, and fails to serve the purpose for which it is applied.

How to slake lime.- The most valuable form of lime is calcium oxide or quicklime, obtained by burning calcium carbonate rock. It is described by gardeners as white or Derbyshire lime, and is available in all parts of the country. It is supplied in lumps, stones, or cobs, in which form it is valueless. The lumps must be broken down by slaking into the finest possible state of division, so that the material can be intimately mixed with the soil. Methods of slaking are to dig a hole in the garden, empty the lumps into it, cover them with soil, and apply as soon as the lumps have absorbed sufficient moisture to reduce them to powder. Water may be poured on the lumps also. Most gardeners prefer the soil method, as there is less danger of slutting or puddling, Fig. 7.

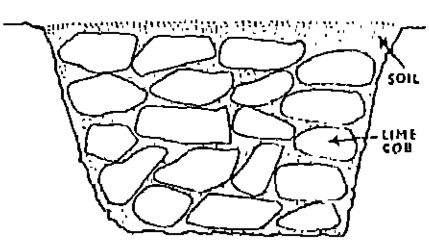


FIG. 7. DIAGRAM SHOWING IDEAL METHOD OF SLAKING QUICKLIME. LIME COBS IN SOIL-COVERED HOLE IN GARDEN

How to apply lime.—Choose a calm day for the application, otherwise wind will interfere with the distribution rate. Fork in

4 to 6 in. deep a 6 oz. per square yard dressing, which is sufficient to keep the soil in good condition for three years.

Chalk.—Carbonate of lime, or chalk, is often used in districts where it is available. Heavy transport charges preclude its employment in others. Chalk is quite as good as lime, except in one respect—it is not quite as hot or caustic, hence the disease and pest controlling effect is not so pronounced. An appropriate rate of application is 10 oz. per square yard.

Lime haters.—To every rule there are some exceptions. In this case we find that certain garden plants, notably rhododendrons, azaleas, heaths, and ferns are calciphobes or lime haters. Exclude them from the liming programme.

USEFUL HINTS

Making a manure heap.—Farmyard manure is so scarce that supplies should be laid in whenever they are accessible, and stored in a shady place. Press the heap very firmly, to reduce aeration, which dissipates the food content. Make the top of the heap ridge-shaped, and cover it with boards or turves, to throw off the rain, another food dissipator. If when forming the heap, any part of the manure is dry, sprinkle it with water, or the bedding material will become mouldy or fanged, Fig. 8.

Making a compost heap.—The compost heap provides a valuable means of supplementing farmyard manure. In every garden there are quantities of succulent, healthy rubbish which on partial decay become humus. If they are mixed with manure, they absorb food from it, and acquire manurial as well as humus value. The compost heap is made in a manner similar to that described for a manure heap, the rubbish and manure being laid down in alternate 4 in. layers. When the rubbish decays, the heap is chopped from top to bottom, and the two layers mixed, Fig. 9.

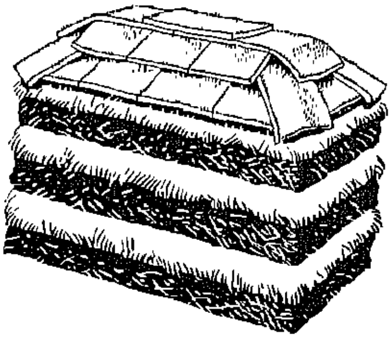


FIG. 8. DIAGRAM SHOWING HOW TO MAKE A MANURE HEAP

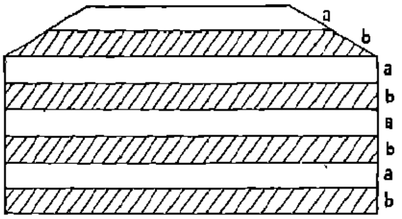


FIG. 9. COMPOST HEAP

a. Layer of vegetable refuse.
b. Layer of farmyard manure.

Making an incinerator.—There should be an incinerator in every garden for the destruction of diseased, pest-ridden crops, intractable material such as potato haulm and cabbage stumps, and perennial weeds like couch grass and coltsfoot. The ashes, being rich in potash, should be stored in a dry place for use later.

The conversion of rubbish into manure.—The scarcity of farmyard manure has necessitated research work into synthetic processes, and there are now sold various preparations which, when mixed with healthy garden rubbish quickly promote decay, the decayed material being approximately equal, in food and humus value, to farmyard manure. An alternative to the proprietary methods is to dig a pit, empty the rubbish into it in 4 in. layers, and on every layer sprinkle 1 oz. of sulphate of ammonia per square yard. Cover the pit, and the material will quickly decay.

Testing for lime.—An excellent test of the need for a lime application is to place a tablespoonful of soil in a tumbler. Add sufficient water to convert the soil to a thin cream. Pour a few drops of hydrochloric acid or spirits of salts down the side of the tumbler. If there is marked effervescence when the acid meets the soil cream, there is plenty of lime present for the purposes of cultivation. The bubbles are carbon dioxide split off from calcium carbonate, Fig. 10.

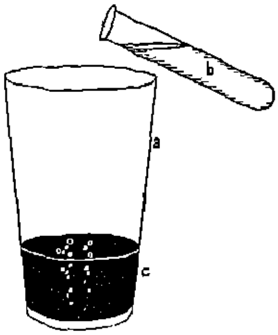


FIG. 10. DIAGRAM SHOWING HOW TO TEST SOIL FOR THE PRESENCE OF LIME

a. Tumbler.
b. Test tube containing hydrochloric.
c. Soil cream.

The lime haters.—The species that are lime haters are lovers of an acid medium. Peat is the best. Thus, where rhododendrons, azaleas, heaths, and ferns are grown, an abundance of peat should be mixed with the soil. A useful experiment would be to plant one rhododrendron in a peaty medium, and another in limy soil. Carefully note the effect of the two substances on growth.

How to make liquid manure.—Secure a barrel fitted with a tap near the bottom. Place in a bag 1 lb. of farmyard manure for every gallon of water. Tie the neck of the bag. Suspend the bag from a rail nailed across the top of the barrel. Fill up with clear water. Cover the top of the barrel, to prevent oxidation. In three or four days some of the food content of the manure will have passed into the water, which is, in effect, liquid manure. Draw from the barrel when this fertiliser is needed, and dilute it to quarter strength with clear water. After each withdrawal, fill up with clear water, Fig. 11.

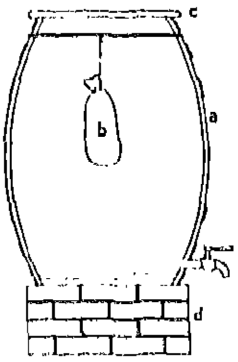


FIG. 11. DIAGRAM SHOWING HOW TO MAKE LIQUID MANURE

a. Barrel.
b. Bag of farmyard manure.
c. Cover of barrel (Board).
d. Brick base.

Unsuitable conditions for soil cultivation.—Land must not be dug during frosty weather, or the frosted lumps turned in will not thaw for months, thereby greatly depressing the soil temperature. For a similar reason snow must not be dug in, while it is inadvisable to dig when the land is very wet, as the texture is adversely affected.

CLASSROOM WORK

Much useful classroom work can be done on soil and soil problems on wet days when it is impossible to work in the garden.

The weighing of soil.—Fill two canisters of equal size with sandy and clayey soil respectively. Weigh the two. Note that the sand weighs heavier. Explain that the terms light and heavy have no connection with weight, but refer to the ease or otherwise with which soils can be worked.

Humus.—Show a sample of leaf mould. Let the children handle it and convince themselves that it is organic matter in a state of decay. Follow with an explanation of the function of humus.

Capillarity.—Fill two clamped tubes, each 1 metre long and 1 cm. inside diameter. Fill the tubes with fine sand and clay respectively. Immerse the end of each tube in a beaker of water, and note the progress of the water upwards. Then explain capillary action in the soil.

The retention of water.—Fill two flower-pots with soil, one sand the other clay. Pour the same quantity of water on to each. Make a record of the time that clapses before the water issues from the bottom of each pot. Follow with a description of the water-holding capacity of different types of soil, and the effect of this on plant life.

The slaking of lime.—Place a small piece of quicklime in a mortar. Pour sufficient water on to it to induce slaking. Let the children observe the evolution of heat, swelling, and falling to the fine powder which represents slaked lime. Emphasise the fact that this process is necessary before lime can be mixed with the soil.

The texture of heavy soil.—Bring into school a lump of wet clay or heavy soil. Squeeze it with the hand. Let it stand in a dry place. Note how it hardens. Explain that this takes place in the garden when heavy soil is worked in a wet condition.

Weathering.—Secure a lump of wet clayey soil, and stand it in a position where the weather will act upon it. After a time the lump will break up and fall to a fine powder, especially if the experiment is conducted during winter.

Artificial fertilisers.—Place samples of nitrate of soda, sulphate of ammonia, superphosphate of lime, basic slag, bone meal, sulphate of potash, kainit, and muriate of potash in large test tubes. Familiarise the children with them. Have a bulk sample near, and teach them how to mix composite samples for application. Thus 3 parts superphosphate of lime, and 2 parts sulphate of potash constitute a good dressing for potatoes, while 4 parts superphosphate of lime, and 1 part each sulphate of ammonia and sulphate of potash constitute a good general dressing. Explain that the parts are by weight and not by bulk. Compare these artificials with leaf mould, pointing out their physical differences, and explaining the significance of them.

II. THE SCHOOL GARDEN EQUIPMENT

Tools and their uses.—Adequate equipment is highly essential to good work. In the absence of proper accommodation, tools quickly deteriorate, and endless time is lost in seeking them when they are needed. Unless each pupil has a reasonably complete kit of tools, it will not be possible on all occasions to keep the class profitably employed. This leads to lack of interest and confusion, while the work of the garden falls into arrears.

The tool shed.—The size of this structure will vary in accordance with the number of pupils taking gardening. A shed 16 ft. long by 10 ft. wide will accommodate the equipment needed for a teacher and twelve pupils. It should be built in a convenient position for easy access to the plots, while the tools should be hung on hooks along the side of the shed. Keep each pupil's tools separate. Have the tools and hooks numbered. Allocate a number to each pupil, so that he can be held responsible for the condition of the tools apportioned to him. There should be a window on one side of the shed. Underneath the window fix a bench on which demonstration can be given, and work such as boxing and cutting seed potatoes carried out. Beneath the bench there should be lockers for the storage of artifical manures, and a separate locker is needed for small tools such as dibbers, trowels, and hand forks. Behind the door it is an excellent idea to have a plan of the school garden, with charts showing the progress of the work and date respecting the condition of crops. Really, the tool shed should be the headquarters of the team, a sort of club house in which those having similar hopes and aspirations meet. At the beginning of each gardening term the teacher should issue instructions regarding the use of tools, accompanying his explanation by suitable demonstrations. He should also make it clear that every tool must be returned to its appointed hook at the end of each lesson, with all soil removed, and the steel parts rubbed with a greasy rag. Once a week it should be the duty of a member of the class to sweep up the shed, and see that everything is in proper order. A rota might well be arranged for this work.

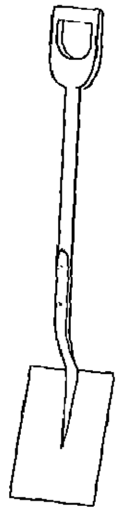


FIG. 12.
SPADE
Eye handle.

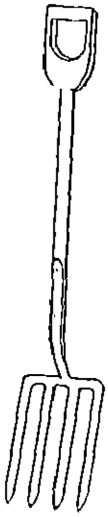


FIG. 13.
POTATO FORK
Flat tine.

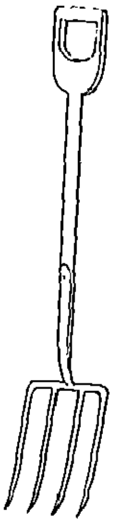


FIG. 14.
DIGGING FORK
Square tine.

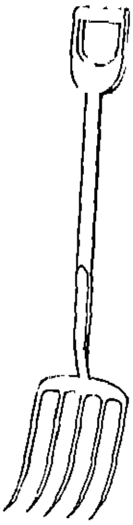


FIG. 15.
MANURE FORK

Digging tools.—The principal item here is a good spade. The eye handle is better than the T handle, Fig. 12. It works with less friction to the palm of the hand. The blade must be firmly riveted to the handle. A four-tined digging fork is an essential also. Each tine should be square and made of the best steel, or there will be constant breakages. A four-tined potato fork, with flat tines is useful for lifting potatoes and other roots, but is not strong enough for ordinary forking. This type of fork should be included in the equipment, Figs. 13, 14 and 15.

Hoes.—There are two types, Dutch and draw. The first named is used solely for creating a good surface tilth and destroying weeds. The type having a 5 in. wide blade is convenient to use, does the work quickly, and can be operated in small spaces. The draw hoe is used for forming seed drills, dislodging large weeds, and earthing up crops such as potatoes, peas, and beans. The type known as the Bury draw hoe is the best. It has a swan-necked approach to the blade, and is, therefore, easily manipulated. The triangular hoe is a valuable tool for forming shallow, narrow seed drills. As the name indicates the blade is triangular.

Rakes.—There are two patterns of garden rakes, the one-piece rake, in which the teeth and the cross piece are formed out of one sheet of steel, and the type in which the teeth are riveted to the cross piece. The latter is less satisfactory as the teeth are continually working loose, whereas the teeth of the former wear away to futility without displacement. Rakes of this type give a long life of excellent service, Figs. 16, 17 and 18.

Manure forks.—These are useful but not really essential. Each has five tines. The latter, being oval or round, are more easily stuck into a heap of manure, thus helping with one of the most laborious jobs in the school garden.

Small tools.—Short-handled trowels are a necessity. They are preferable to the long-handled type, which is clumsy to use, especially in the hands of a child. The one having a 6 in. long blade is the best. Hand forks must be provided for loosening soil that is inaccessible to the Dutch hoe. The three-tined type having a short handle works satisfactorily. Dibbers are valuable for planting small subjects. Undoubtedly the best type is the one having its point shod with steel. There is no fear of breakages and point blunting. It is, however, possible to make effective dibbers by cutting brush or rake handles into 9 in. long pieces, and making a point at the base of each. To ensure straightness of drills, a line must be included. It should be of strong cord not likely to buckle or contract with wet, and it is an advantage when the cord is wrapped round a steel reel, and attached to a steel pin at the other end, Figs. 19, 20 and 21.

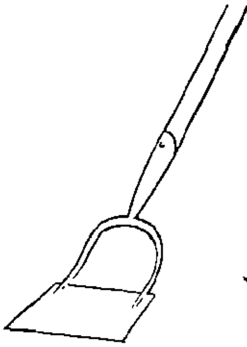


FIG. 16.
DUTCH HOE

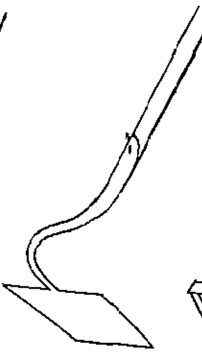


FIG. 17.
BURY DRAW HOE
Swan neck.

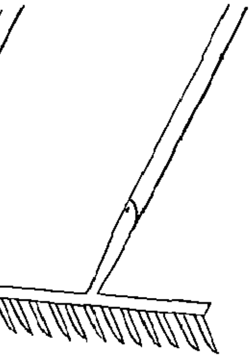


FIG. 18.
RAKE
Made in solid piece. Note absence of rivets.

Wheelbarrow.—One wheelbarrow is sufficient for each gardening class. When not in use, it should be taken into the tool shed, as if left outside weather changes will quickly deteriorate the wood, especially the felloes of the wheel, which eventually separate, causing total collapse.

Cold frame.—A cold frame is indispensable. The two-light type is the most suitable, because it enables differential treatment to be given to the various subjects that are appropriate for this class of culture. The cultures are dealt with later. Here the specification for a suitable frame is given. Each light should be 4 ft. long by 3 ft. wide, and must be glazed with 21 oz. horticultural glass. Make the back of the frame 18 in.

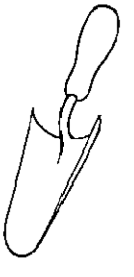


FIG. 19.
TROWEL

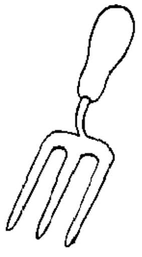


FIG. 20.
HAND FORK

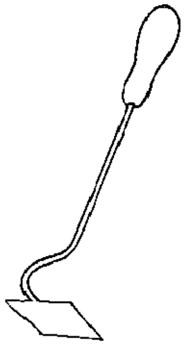
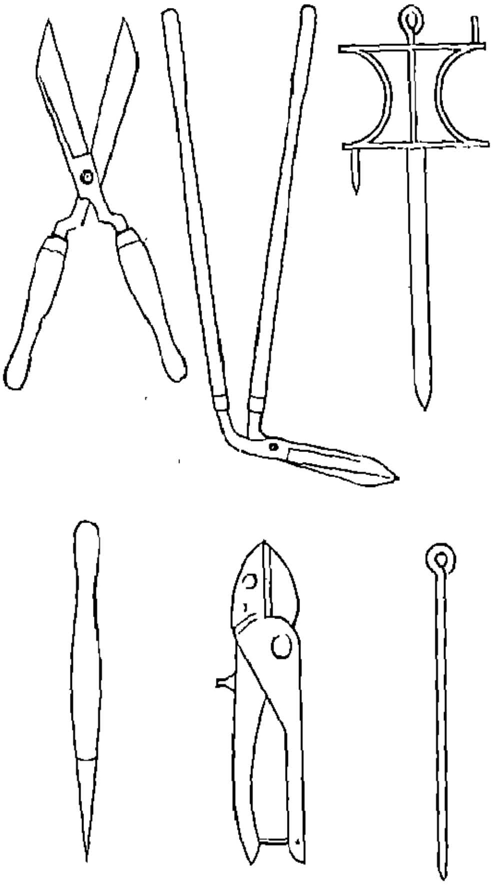


FIG. 21.
ONION HOE

high, the front 9 in. For the wood part, use ¾ in. thick seasoned deal. Stand the frame in a sunny, sheltered part of the garden. The number of two-light frames needed depends on the number of pupils taking gardening. For a class of twelve one two-light frame is adequate.

Flower gardening tools.—All the above tools are equally necessary for vegetable and flower gardening. Where the latter is taught, there will be needed in addition a pair of hedge shears for clipping hedges, edging shears for clipping lawn edges, secateurs for pruning, an edging knife for straightening broken lawn edges, and a 12 in. mower for cutting the lawn, Figs. 22 to 27.



FIGS. 22 TO 27. GARDEN TOOLS

In the top row, from left to right the drawings show hedge shears, edging shears and a reel for a garden line.

In the bottom row, from left to right the drawings show a dibber, secateurs and a pin for a garden line.

How to use tools. Gardening operations can be very irksome and tiring unless performed according to methods proven by experience to be the best. Demonstrations in the use of each tool should be given, and a careful watch kept on the children's movements, otherwise, in accordance with human perverseness, they will choose the wrong method. In no instance should the handle of a tool be gripped too firmly. When the hands are allowed to slide reasonably, as the tool changes position, the operation is less tiring to the muscles.

When digging, push in the spade blade vertically, and do not attempt to move too wide a strip of soil. 6 in. is quite sufficient for a child. The spit should first be nicked on each side, the blade pushed in with the aid of the right foot, and the soil turned a complete somersault. Forking is done on similar lines, with the exception that there is no need to cut out the spit or chunk of soil. When drawing seed drills, first stretch the line tightly, then straddle it, and work out the soil to the required depth with the corner of the draw hoe. Operate with a series of jerks rather than long pulls, which inevitably result in a switchback drill. When Dutch hoeing, start at one end of the plot, push the blade into the depth of 1 in, and work the part hoed away from the blade, so that there is no danger of covering standing weeds or caked land. When raking, do not dig the teeth into the ground, or it will be impossible to get a level surface. The body should be bent fairly well over, and the land combed.

The trowel is used for planting any flower or vegetable which has a ball of soil attached to its roots. Make a hole large enough to receive the ball comfortably, and fill in gradually and carefully with fine soil. Obviously such a method would be clumsy if applied to small seedlings that are lifted with an infinitesimal amount of soil. The smaller hole made by the dibber affords ample accommodation for their roots. The hole should be filled in by working into it sufficient soil with the dibber point. A firm press with the latter secures the plant.

The easiest way of doing barrow work is to push a load, and pull when the barrow is empty. The illustration shows how to load a wheelbarrow, Fig. 28. When clipping hedges, always work backwards way, so that the part clipped is kept in view, and symmetry preserved. Lawn edging shears work most efficiently when the clipping is done with the points only. These must be kept close to the lawn margin, or a fringe of grass will remain.

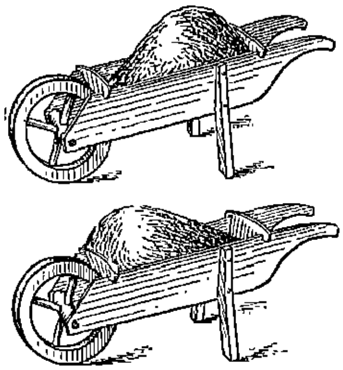


FIG. 28. HOW TO LOAD A WHEELBARROW

A. Wrong way, with the weight on the handles.
B. Right way, with the weight on the front.

Lawn mowing demands special care. Always oil the machine thoroughly before starting, but never on the turf, or the oil drippings will do great damage. Do not press on the handles or the cutting blade and cylinder will be lifted from their work. Lift the handles slightly, push vigorously, and walk quickly at the same time. Then the cut will be close and clean.

USEFUL HINTS

The use of the spade.—It is well worth while giving a full lesson to this important operation, the teacher demonstrating incorrect methods and the correct method. He should push in the spade blade at various angles, on each occasion measuring the depth of the digging. Having done this, push in the blade vertically, afterwards comparing the various depths. Follow with observations on the value of deep cultivation, and the necessity for pushing in the blade vertically.

Digging dry soil.—Make an effort to dig dry soil. Note how difficult it is to push in the blade. Afterwards water a small plot of dry soil, and as soon as the water drains away, dig it. Note how watering greatly reduces the labour.

The use of the rake.—Lay a rake flat on the ground with the teeth pointing upwards. Press the teeth slightly with the foot. Note how the handle flies up. If the pressure is heavy it may strike the face of the person passing over it. Point out that when the rake is not in use it must be laid teeth downwards.

Dutch hoeing.—Push the blade of the hoe deeply in for the purpose of showing how impossible it is to create a soil mulch when used in this way. Follow by pushing in the blade 1 to 2 in. deep, explaining that the surface looseness which results is one of the main reasons why the Dutch hoe is used.

CLASSROOM WORK

When to use certain tools.—Let the children make records of the tools needed for cultivation during the varying seasons.

Tools needed for winter.—Spade, digging fork, manure fork.

Tools needed in summer.—Rake, draw hoe, Dutch hoe.

Tools needed for sowing.—Draw hoe, rake, line.

Tools needed for planting.—Fork, rake, trowel or dibber.

Tools needed for earthing up.—Draw hoe, spade.

A classification of this kind will prove very useful. All the teacher needs to do when the knowledge is thoroughly digested is to instruct each pupil to bring out his sowing tools, planting tools, or whatever tools are needed for the operation on hand.

III. VEGETABLE PRODUCTION

ROOT CROPS

The cultivation of vegetables is a valuable educational factor on many grounds. It provides a medium for the teaching of all kinds of soil treatment, sowing methods, thinning, in-season feeding, pest control, and the maintenance of an all-the-year-round food supply. Suitable dimensions for the school vegetable plot are length 30 ft., width 15 ft. In such a plot there is room to grow a representative of the leading types of vegetables. The plots should be grouped in one part of the school garden, their number to depend on the number of pupils in the gardening class, and the number of gardening classes. Two pupils should work each plot. It is beyond the compass of one boy to manage a plot of this size in the time allotted. In this chapter the cultivation of root crops will receive attention.

The potato.—The potato is our second most important food crop. It is propagated vegetatively. The true seed is not used in ordinary garden practice. The tubers that are planted, known as sets or seed tubers, are swollen underground stems. This fact should be fully explained, as it has an important bearing on cultivation. Proof that the potato is a stem and not a root is afforded by the fact that on exposure to light it turns green and that it bears stems and leaves. It should be explained that when a crop is propagated vegetatively, it is much more liable to deterioration than when true seed is used. The latter represents the union of two generations, producing an entirely new organism. The "seed" potato is a little bit of the old plant reserved to produce a crop the following year.

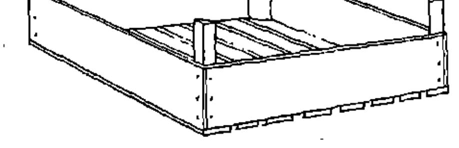
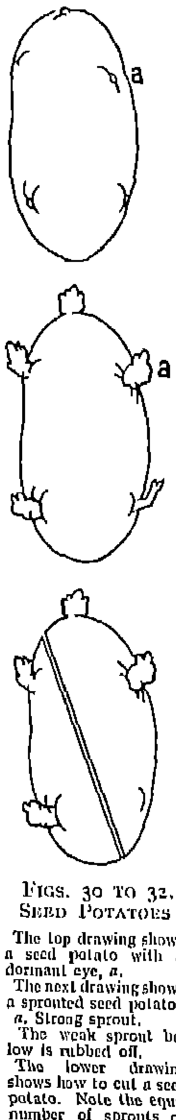


FIG. 29. POTATO SPROUTING BOX

a. Corner supports, enabling boxes to be piled one above another without excluding light.



FIGS. 30 TO 32. SEED POTATOES

The top drawing shows a seed potato with a dormant eye, *a*.

The next drawing shows a sprouted seed potato, *a*, Strong sprout.

The weak sprout below is rubbed off.

The lower drawing shows how to cut a seed potato. Note the equal number of sprouts on each cut part.

Three years in one garden are sufficient to make a stock of potatoes unremunerative. A change becomes necessary. It is made by introducing stock from those parts of Scotland, England, and Wales in which aphides do not attack the foliage and transmit virus diseases. That is the most modern interpretation of the virility of seed potatoes grown in areas more or less reserved for their production. The cultivator is protected by statute, as every seed potato merchant is required to issue a certificate giving the origin of the stock he sells.

Sprouting.—This is the term applied to the forwarding of growth for planting. In January or February the seed potatoes are set up close together in shallow boxes with the rose end upwards. The boxes are stood in a cool, light shed or room, where the dormant eyes grow out very slowly, and form sprouts or young shoots. The advantages of sprouting are a heavier yield, the elimination of tubers markedly affected by virus disease, and in the case of early varieties an earlier lifting date. It is calculated that sprouting increases the yield by approximately 10 per cent. It is obvious that when seriously diseased tubers *are* removed, there must be fewer gaps in the rows, and less danger of the disease being transmitted to healthy plants, Figs. 29 to 32.

The cutting of seed potatoes.—All seed potatoes that are larger than a hen's egg should be cut lengthways into two more or less equal portions, reserving on each portion the same number of sprouts. Immediately after cutting, rub the cut surface in dry soil or sand, to prevent loss of sap by bleeding. The process may take place at any time after the sprouts are ¼ in. long. The reason for cutting is purely economic. Seed potatoes are expensive, and as half a big potato gives as heavy a yield as a whole one, it is important to make the seed go as far as possible.

Soil preparation.—Potatoes like a very friable, well-worked soil. Unless the texture is perfect, the tubers are misshapen. During the winter previous to planting, the soil should be dug 2 ft. deep, so that alternating frost and thaw can ameliorate it, and bring it to the desired condition. Do not incorporate stable manure when digging. Leave that until planting time. By so doing the food supply and common scab disease control can be linked together. When potatoes are planted directly on manure, the fungus responsible for common scab is attracted to the manure, and the tubers escape. There is no better method of control. Obviously there is the weakness that the disease organism is still left in the soil. So far there has been discovered no method of destroying it. Until that discovery is made gardeners must be satisfied if by any means they can keep their potatoes clean. A few days before planting, fork the soil a foot deep, break down the lumps, and tread fairly firmly.

When and how to plant potatoes.—There are three sections, early, second early, and maincrop. The first named are not very heavy yielders. They are grown because they *are* early, hence the sooner they are planted, the better. Early to mid-March is a good period. Second earlies give heavier yields, and keep in good condition until Christmas, after which they decline in table value, even if the tubers remain sound. They can be lifted from mid-August onwards. The end of March is an excellent planting period. Maincrop varieties return the heaviest yields, and though they can be used at any time after lifting in early October, the flavour is at its best in the New Year. Early to mid-April is the planting period.

These sections differ in vigour, earlies being the least vigorous. The planting distances must, therefore, be adjusted to meet the variation. Thus, appropriate planting distances for earlies are rows 2 ft. apart, seed potatoes in the rows 1 ft.; second earlies, rows 28 in. apart, seed potatoes 14 in.; maincrops, rows 30 in. apart, seed potatoes 15 in.

The drill method of planting is the most suitable. It consists of forming with the spade 8 in. deep, V-shaped drills. Spread 3 in. of farmyard manure at the bottom, and plant on this. To cover up the potatoes, split each ridge of soil with the draw hoe, and make a similar ridge over the drill. By so doing, the maximum area of land is

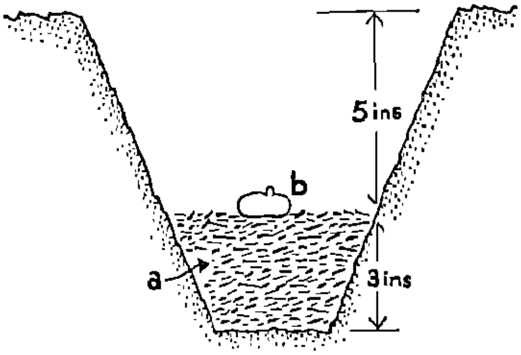


FIG. 33. DIAGRAM SHOWING PLANTED POTATO DRILL

a, Manure.
b, Seed potato.

exposed to the helpful factors of warmth and aeration. Handle the sprouted tubers with great care, and do not reduce the number of sprouts beyond rubbing off any that are so weak as to be clearly useless, Fig. 33.

Early attentions, feeding, and earthing up.—As soon as the haulm or growth appears, Dutch hoe between the drills. It is highly important that the soil shall not be allowed to cake, as this means deficient aeration and loss of soil moisture. Early, and to some extent second early varieties, may appear before the danger of spring frosts is past. If they do, protect them on threatening nights by covering the haulm with straw, dried bracken, or inverted boxes. Remove the covers the following morning as soon as the frost departs.

When the haulm is 9 or 10 in. tall, sprinkle evenly on each side of it, without touching the stems or leaves, a 1 oz. per yard run dressing, of a mixture of 3 parts superphosphate of lime and 2 parts sulphate of potash. Nitrogen is omitted from this valuable in-season feeding programme because it emphasises haulm development and makes the tubers watery. Follow by earthing up on each side of the haulm a 4 to 5 in. high bank of finely pulverised soil. It should be explained that earthing up, by imposing a slight check, promotes the earlier formation of young tubers, encourages them to form round the base of the haulm, and prevents them from becoming green, and therefore harmful as food, owing to the solanin which develops on exposure to light, Fig. 34.

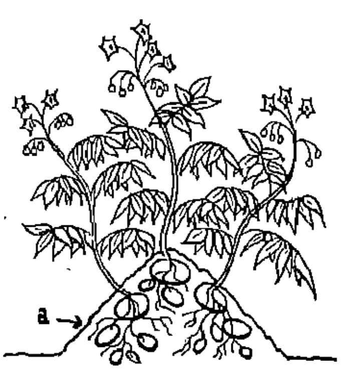


FIG. 34. SHOWING HOW TO EARTH UP POTATOES
a. Soil bank.

Lifting and storage. Potatoes are ready for use when the haulm yellows naturally. Earlies and some second earlies are lifted at this stage for immediate consumption. Use a four-tined fork for lifting. First pull up or cut off the haulm, which otherwise will get in the way. Push in the tines to their full depth, and after sorting out the first lift, fork more deeply, to secure the few tubers that always form on long runners.

Second early and maincrop varieties intended for storage must remain in the ground until the tubers are quite ripe. This condition can be tested by reference to the tubers themselves. Lift a few typical examples. Rub the skin vigorously with the finger and thumb. If it adheres to the tissues below, the right stage of ripeness for lifting has been reached. Should the skin rub off easily, the crop must be left in the ground to ripen properly.

Choose dry weather for lifting, and before storing, remove the chats or small tubers, those that show signs of decay, and any that under the three year rule are to be planted the following year. Store the last named in single layers in boxes, and keep them in a cool but frost-proof shed until sprouting time. Expose the ware or table crop remaining to a drying wind for twenty-four hours, to make sure that the tubers are thoroughly dried and therefore do not themselves create conditions that will cause their own decay.

In the storage environment, darkness, dryness, and freedom from frost must prevail. Many cellars, outhouses, and spare rooms provide these conditions. In them the crop may be accommodated in boxes, sacks, or beneath a 4 in. layer of clean straw. Where the quantity is too great to permit indoor storage make a clamp out of doors in a sheltered situation, the dimensions to be width at base 4 ft., height 4 ft., width at ridge 1 ft. Pile the potatoes in a heap of the shape delineated by these dimensions, and cover them with 4 in. of straw. When severe frost threatens, cover the straw with 4 in. of soil taken out in the form of a channel around the heap. When soiling the ridge, work in a 3 in. land tile in a slightly slanting position at intervals of 3 ft., to admit air to the stored crop. When storing either indoors or in clamps, mix with each stone of potatoes ½ oz. of flowers of sulphur or freshly slaked lime, to keep down moulds and other decay organisms. At intervals of three weeks examine the crop, and eliminate any tubers that show signs of decay, Figs. 35, 36 and 37.

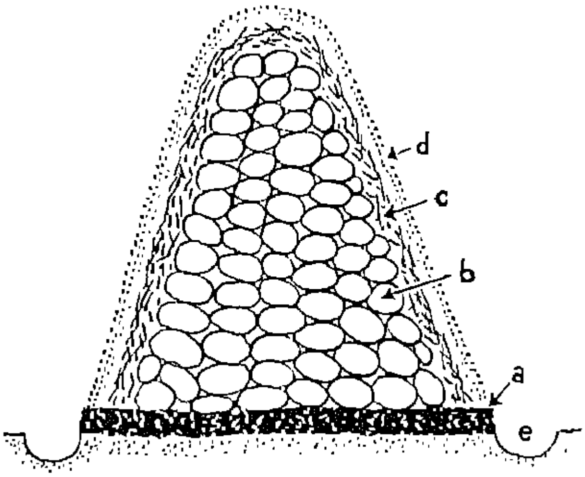
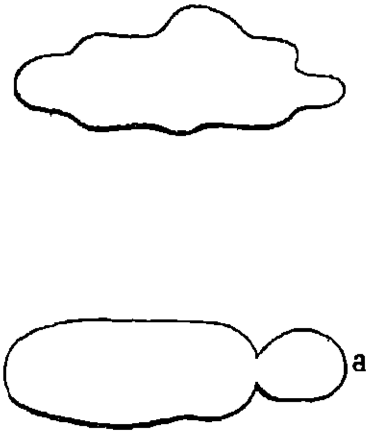


FIG. 35. POTATO CLAMP

a. Cinder base.
b. Potatoes.
c. Straw layer.
d. Soil layer.
e. Channel from which soil was taken.

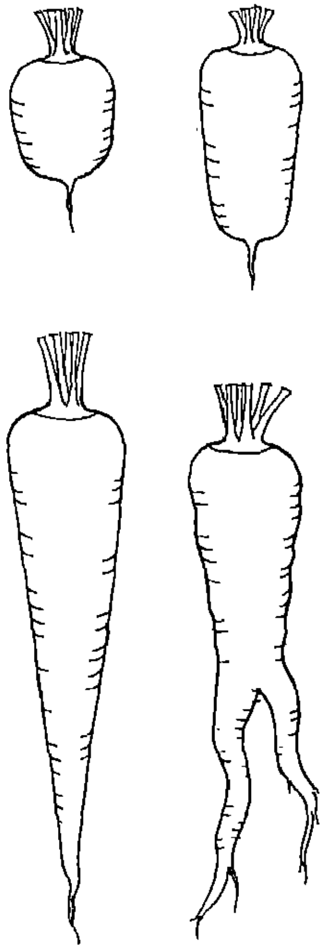


FIGS. 36 AND 37. THE EFFECT OF VIOLENT WEATHER CHANGES ON POTATOES

The top illustration shows a potato with supertuberation, due to violent weather changes, and the lower illustration shows a potato with a secondary growth (*a*) also due to violent weather changes.

The carrot.—There are three sections of the carrot,—shorthorn, intermediate, and long. The first named is not of great economic significance, though it is a useful catch crop for lifting, in summer. It should be grown to illustrate the value of catch cropping. When sown between rows of permanent crops such as peas, beans, or summer cauliflowers, or on the ridge of celery and leek trenches, it gives an excellent return, while occupying only land that is under the major occupation of some main crop. Intermediate carrots are the most valuable section. Their 6 to 9 in. long roots are grown solely for storage and use in winter. The roots of the long section are often 15 to 18 in. from crown to tip. They cannot be produced successfully without laborious and costly preparations in any but the few soils that are naturally rich and of excellent texture to a depth of 2 ft. As such soils are very rare, long carrots are not much grown, Figs. 38, 39, and 40.

Soil preparation.—Considerable care is necessary. Intermediate and long carrots like rich conditions, but stable manure must not be incorporated within six months of sowing, otherwise the roots will fork and crack. The ideal site is one on which peas, beans, celery, or leeks were grown the year before as these crops are heavily manured. The residue of food left behind is sufficient to see the carrots through without the use of stable manure at all. To provide the necessary root plunge, dig 2 ft. deep during the previous winter. A fortnight before sowing, fork 1 ft. deep, break up the lumps finely, tread fairly firmly, and rake into the surface 4 in. a 2 oz. per square yard application of equal parts superphosphate of lime and sulphate of potash. For shorthorn carrots



FIGS. 38 TO 41. CARROTS

In the top row the first illustration shows a short-horn carrot and the second picture shows an intermediate carrot.

In the lower row the first picture shows a long carrot and the second picture shows a forked carrot, caused by using farmyard manure.

make no special soil preparations. Their roots are but 3 or 4 in. long, hence they derive plenty of nutriment from the food added for the main crop.

When and how to sow the seed.—To maintain a succession of shorthorn carrots, sow at three-weekly intervals from mid-March to mid-August. Sow intermediate and long varieties from the middle to the end of March. Both need a lengthy season of growth. In all cases make the drills 1 in. deep. Space those for shorthorns 6 in. apart, intermediates 12 in., long 15 in. Mix a little sand with the seed to facilitate even distribution.

Thinning.—This is an important operation in carrot culture. Shorthorns are thinned to allow sufficient room for development. The process is progressive. The first plants are taken out when their roots are the thickness of the forefinger. Others are removed at short intervals until the last gathering, yielding the largest roots, finishes at 6 in. apart. Intermediate and long varieties are thinned on three occasions in successive weeks. On the first the seedlings are reduced to groups of three, at half the final distance. On the second alternate groups are removed. On the third the seedlings in the remaining groups are reduced to one. The first thinning must take place before there are signs of congestion. Choose showery weather, or water the day before each thinning. The superfluous seedlings withdraw more easily from moist soil. Pull them up carefully in small clusters. The permanent seedlings are easily damaged by rough handling, Fig. 42.

Feeding, lifting and storage.—Intermediate and maincrop carrots are great potash lovers. Their full cropping possibilities are explored by applying sulphate of potash (1 oz. per yard run of drill) from the time the crop is half grown until it is ready for lifting. Water the fertiliser in if the soil is dry, stir it in if moist. When, sometime in early October,

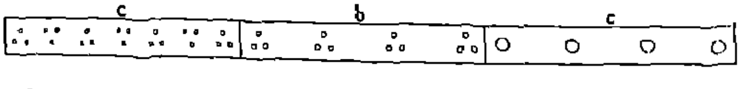


FIG. 42. PLAN OF CARROT DRILL, SHOWING HOW TO THIN SEEDLINGS

a. First stage, groups of three, 6 in. apart.
b. Second stage, groups of three, 12 in. apart.
c. Final stage, single seedlings, 12 ins. apart.

the outer leaves fall over, lift the crop, using a fork to ease out the roots. Shake off as much soil as possible, but do not wash the skin, or shrivelling will follow. Cut off the leaves as near the root tops as possible, afterwards storing the roots in an outhouse. A little frost does not harm carrots. Use sand or leaf mould as the storage medium. Lay the roots in single tiers separated by 2 in. layers of the storage material, afterwards covering the sides and top with a layer of similar thickness. The crop is not susceptible to storage diseases, but towards spring there often develop secondary leaves which exist at the expense of the material stored in the roots. Cut these off, or the food value of the crop will vanish, Fig. 43.

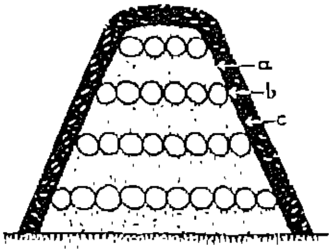


FIG. 43. DIAGRAM SHOWING HOW TO STORE CARROTS

a. Sand layer.
b. Layer of carrots.
c. Layer of leaf mould.

The parsnip.—This is a valuable tap-rooted vegetable grown entirely for winter use. It is very susceptible to Rust, a physical disorder which causes the root tissues to break down and decay. Seeing that no insect or fungus is responsible for the trouble, spraying is useless. Rust is more prevalent in heavy soils. Their texture seems to act unfavourably on the epidermis. To overcome this disadvantage, special stations are prepared by boring 2 ft. deep holes with a crowbar or stout stake. Space the stations alternately at an all-round distance of a foot apart. Fill each station fairly firmly with a finely sifted mixture of loam 3 parts, leaf mould and sand 1 part each, with 2 oz. of bone meal to the pailful. Excellent Rust-free roots are produced under these conditions, Fig. 44.

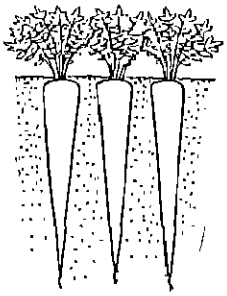


FIG. 44. PARSNIPS GROWING IN PREPARED STATION

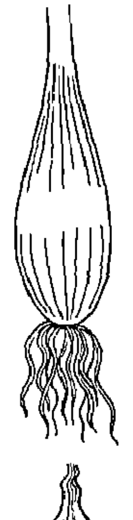
In medium and light soils it is unnecessary to prepare special stations. Treat the soil precisely as suggested for intermediate and long carrots, as parsnips are just as liable to fork and crack when farmyard manure is used.

When and how to sow the seed.—A long season of growth is essential, hence the seed is sown as early in February as the ground is fit. Make the drills 1 in. deep, and set them 1 ft. apart. Sow fairly thickly, as the seed has a low germination percentage. It germinates slowly, hence the reason why a little lettuce seed is often mixed with it, to mark the position of the drills quickly, so that hoeing can proceed between them. The lettuce remains, but is gathered when small. Drills, of course, cannot be made in prepared stations. Sow six or seven seeds equidistant in each, and cover them with an inch of soil.

Thinning and feeding.—Before overcrowding arises, thin the seedlings gradually to 12 in. apart on exactly the lines suggested for carrots. Reduce the number of seedlings in the prepared stations to one before overcrowding occurs. After the crop is half grown, until the middle of October, feed at fortnightly intervals with equal parts superphosphate of lime and sulphate of potash at the rate of 1 oz. per yard run. Feeding ceases in mid-October because it is inadvisable to encourage root-swelling afterwards. The crop is not lifted and stored, as its flavour is improved by frost. After severe weather starts, a layer of straw or littery manure should be placed over a portion of the bed to enable lifting for table use to proceed without interruption.

The onion.—There are two sections of this useful crop, spring-sown and autumn-sown. The differences in appearance are slight, but there is a great difference in the keeping capacity. Spring-sown onions keep in good condition through winter and spring. The autumn-sown must be used a few weeks after lifting, or they will decay.

Soil preparation.—Both sections need a rich soil. It is advisable to dig fully 1 ft. deep, mixing with each square yard ¾ pailful of well-rotted farmyard manure and 4 oz. of soot. For the latter homely, nitrogenous, soil-warming fertiliser, onions have a great affection. After breaking down the lumps finely, tread medium and heavy soils with more than usual firmness. Roll light soils. In the absence of vigorous consolidation the bulbs are spongy. After rolling, rake the surface even.



FIGS. 45 AND 46.
ONIONS

The top drawing shows a bottle necked onion, the result of deep sowing.

The lower drawing shows a normal onion, the result of shallow sowing.

When and how to sow the seed.—The seed of spring onions should be inserted about mid-March, that of the autumn kinds in early August. Both are sown under similar conditions. Make the drills ½ in. deep, and space them 9 in. apart. As it is difficult to form such a shallow drill with the draw hoe, the best way is to lay the rake handle alongside the tightly stretched line which marks the position of the drill, and press it in with the foot to the required depth. Shallow sowing is practised as a safeguard against bottle neck, a condition in which no bulb forms, the stem attaining an inordinate thickness, Figs. 45 and 46.

Weeding and thinning. Hand weeding forms an important part of seedling onion management. For some reason weeds seem to flourish in an onion drill more than anywhere else. They must be pulled up regularly, or the crop will spindle and fail to bulb. The redundant seedlings in a spring onion drill should be used for salading, but this must not be regarded as the main object. See that the permanent plants are thinned to 9 in. apart before congestion develops. Redundant autumn-sown onions can be used for a similar purpose, but not until spring, when they too should be thinned to 9 in. apart.

Feeding.—After both spring- and autumn-sown onions appear, dress them lightly with weathered soot at ten-day intervals until the main feeding season starts, which for the spring kinds is the end of June to the end of August; for the autumn, early June to early August. At weekly intervals during these periods, feed alternately with quarter-strength liquid manure (2 pints per plant per dose) and sulphate of potash (¼ teaspoonful per plant per dose.) The former stimulant assists leaf growth, the latter promotes the storage of reserve material in the bulb.

Lifting and storage.—The ripening appearance of the bulb suggests to the gardener the necessity for lifting. Other indications are the yellowing of the leaf tips, and the gradual falling over of the leaves. When these signs appear, kink the main stem 2 in. above the bulb. Make sure that the kink is permanent, as its object is to intercept the sap flow and expedite maturation, Fig. 47. After a week in this condition, lift the bulbs, and spread them out in full sun until the leaves and roots wither. Then twist off both, and store the bulbs in a dry, cool, airy shed in boxes or bags, or form them into ropes by tying the broken stem ends together, allowing the bulbs to point in an outward direction, Fig. 48. A convenient length for a rope of onions is 2 ft. The method is useful where floor storage space is limited, as ropes can be suspended from roof rafters.

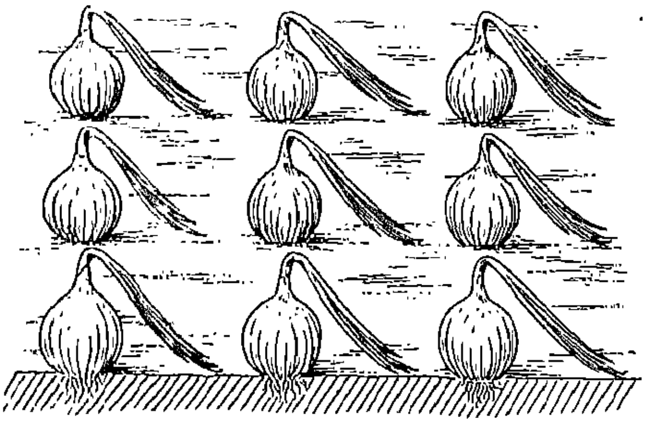


FIG. 47. ONIONS WITH HEADS BENT OVER TO HASTEN THE RIPENING

Beet.—Beet is grown almost entirely for summer and winter salading. Occasionally the roots are boiled and used as a vegetable. There are two sections—round and long. The former is grown for summer salading as well as for use in winter. The latter is grown exclusively for winter use.

Soil preparation and seed sowing.—The position selected should receive full sun. Beet is a total failure in the shade. The soil should be dug one foot deep, and dressed with farmyard manure at the rate of ¾ pailful per square yard. After breaking down the lumps finely, and treading fairly firmly, rake into the surface four inches a 1 oz. per square yard dressing of agricultural salt. Being a maritime crop, beet responds well to the latter fertiliser. The so-called seed is in reality a fruit of the kind known as a capsule. Within the husk or outer skin are three or four seeds. For this reason it is not necessary or advisable to sow beet as thickly as most other vegetables. The correct method is to drop the fruits in twos in 1 in. deep drills, the distance apart of the pairs being governed by the section. For round varieties it is 3 in., for long 6 in. For round sorts the drills should be spaced 6 in. apart, for long 12 in. To maintain a succession of summer salading, sow round varieties at three-weekly intervals from early April until early August. Early May is soon enough to sow long beet. Roots from earlier sowings become too large and coarse before the end of the season.

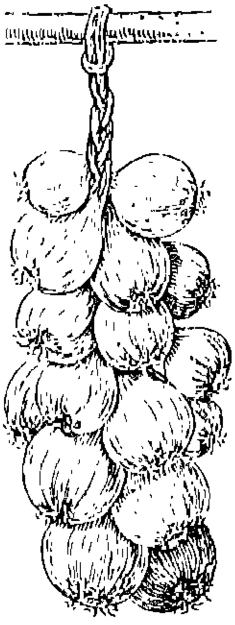


FIG. 48. ONIONS ROPED FOR STORING.

This is a good way of storing onions, as air can get freely to all the bulbs.

Thinning and feeding.—Beet frequently germinates erratically, hence several thinnings may be necessary to clear up the late starters. The final distance for round varieties is 6 in., for long 12 in. This means that in both sections alternate groups of seedlings are pulled up, and those in the remaining groups are reduced to one. Prompt action is essential, as congested beet bolts or runs to seed prematurely. After the crops are half grown, feed every ten days, using superphosphate of lime and agricultural salt weekly and alternately, both at the rate of 1 oz. per yard run of drill.

Lifting and storage.—Beet grown for summer salading is lifted at the will of the gardener. Roots about the size of a tennis ball are favoured for this purpose. Round and long beet grown for storage and used in winter must be lifted sometime between early and mid-October, when it is obvious that the roots have swollen to their maximum size. Choose dry weather, easing up each root with the garden fork. Handle the roots most carefully, or there will be skin bruises and ruptures, out of which the red sap flows so profusely that the crop loses its table quality. As a further gesture towards the preservation of the sap, twist off the leaves, thus forming a sort of tourniquet which effectually prevents bleeding. Store in an open shed, or within cover of a sheltering wall, placing three or four inches of leaf mould over the neatly piled roots.

The turnip.—There are three sections of this vegetable—summer or six week, winter, and swede. The first named are properly regarded as catch crops. They are ready for use ten or eleven weeks after sowing. It is customary to grow them between rows of permanent crops without any special soil preparation beyond forking 6 in. deep if this is necessary in order to secure a good texture. Make the drills 1 in. deep, sow thinly, and thin out the seedlings to 6 in. apart before congestion arises. Make sowings at three-weekly intervals from mid-March until mid-August. Winter turnips are a main crop grown for use in winter. Being specially hardy, they are lifted straight from the ground. Before sowing, in early July, dig 1 ft. deep, working into each square yard ½ pailful of well-rotted farmyard manure and 3 oz. of bone meal, to provide the phosphates which are essential to successful turnip growing. Draw the drills 1 in. deep, and space them 1 ft. apart. If the soil is dry, as it may be at this season, fill the drills with water the day before sowing, to accelerate germination. In dry land the seed may lie dormant for weeks. Thin gradually to 12 in. apart, and in early and late September apply a 1 oz. per yard run helping of superphosphate lime. Swedes are grown on precisely similar lines, with the exception that the seed is sown from mid-May to mid-June, and that the roots are lifted when the first very severe spell of frost threatens. They are not quite as hardy as winter turnips. Store them without any covering in an outhouse, or in a sheltered corner outdoors, covered with 4 in. of fallen tree leaves, or straw.

USEFUL HINTS

Potato planting.—Try two methods of distributing the manure, in the one case placing it beneath the potatoes, and in the other above them. Note the results. It will be found that when the manure is placed below, the crop is less likely to suffer from drought in a hot summer, doubtless due to the greater pull of the manure on the moisture supplies below.

Sprout reduction.—Devote one row to a test on this interesting process, dividing it into three parts. In one part plant without any sprout reduction at all, in another reduce the sprouts to three per tuber, in the third part to one. Take yield records at the appropriate time. It will be found that the weights differ very little but that the tubers are larger as the sprouts become fewer. This is due to the fact that there is a smaller number of underground tuber-producing stems. The test shows that sprout reduction does not affect the cropping capacity of the seed potato.

Flower removal.—Remove the flowers from a few potato plants as they open, later comparing the yield with that of plants allowed to bloom. The latter will show up poorly, proving that flower production absorbs nutriment that would otherwise go into the crop.

Carrot manuring.—Try the effect of growing carrots in land heavily dressed with farmyard manure. This carries conviction as to the root-forking tendencies of this manure. When the children see the deformed roots they will never forget them, and a most valuable manuring lesson will have been impressed. This test might be conducted on the experimental plot.

Parsnip sowing.—Mix a little lettuce seed with the parsnip seed in a few selected drills. It will germinate very quickly, enabling hoeing to proceed much earlier than where the seed was sown alone. Note the effect of this earlier cultivation on the progress of the seedlings.

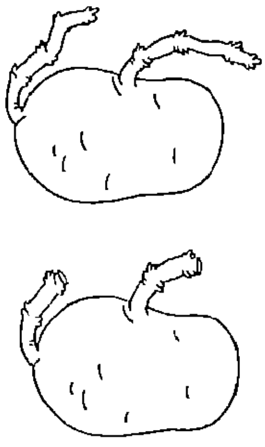
Beet sowing. Steep the seed of some beet over night before sowing it. Sow some without steeping. Take records as to the germination period of each set of seed, and also of the quality of the seedlings. Those from the unsteeped seed will be much weaker, indicating that they had a greater struggle in breaking through the husk.

A turnip suggestion. As soon as turnip seedlings appear, mulch some of them with a ½ in. layer of lawn mowings or grass cuttings. Watch the progress of the mulched and the unmulched. The former grow very rapidly, a valuable aid in turnip culture. The progress is accounted for by the fact that the grass mulch conserves moisture, which is an essential turnip need.

CLASSROOM WORK

Potato classification. Show examples of the different sections of potato—white round, coloured round, white kidney, and coloured kidney. Give examples of varieties in each. State that there are first early, second early, and main crop varieties, and give the earliest date at which each can be lifted after planting:—first early, fourteen weeks; second early, eighteen weeks; main crop, twenty-four weeks.

Potato sprouting. Show a seed potato that has grown spindled sprouts. It may be necessary to bring one on in a warm dark place for this purpose. Explain that by cutting back each sprout to within two joints from its base, the danger of a breakage when planting is overcome. The cut back sprout ultimately branches. Spindling often occurs when planting is delayed through bad weather, Figs. 49 and 50.



FIGS. 49 AND 50. SEED POTATOES

The top drawing shows a seed potato with spindled sprouts. The lower drawing shows a seed potato with spindled sprouts cut back to two joints from the base.

History of the potato.—Give the history of the potato, which according to the most reliable available records was introduced into England from North America by Sir Walter Raleigh. Actually the species is a native of Chile, but it was introduced into North America by the Spaniards. In 1597 a potato plant was engraved in *Merards Herbal*, suggesting that that was the period at which it began to arouse some interest in England. It is now our second most important food crop.

Carrot seed.—Show examples of carrot seed under the magnifying glass, pointing out the small spines. Indicate that these make it difficult to distribute carrot seed evenly, unless it is mixed with an equal quantity of sand, Fig. 51.

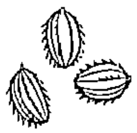


FIG. 51. CARROT SEEDS WITH SPINES

Bird scarers.—The children might make bird scarers by tacking pieces of tin, which can be cut from canisters, on to short pointed stakes. These pieces of tin glitter when placed amongst seedlings, thereby frightening off the birds, Fig. 52.

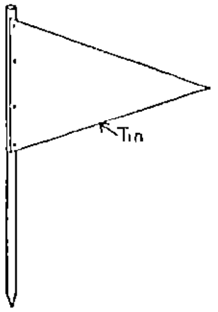


FIG. 52. BIRD SCARERS

Beet seed.—Show sections of beet seed (fruit), pointing out that in each there are two or three compartments, containing a seed or seeds. The number of compartments is not constant, as it is in wild beet, but the fact that the so-called seed is in reality a fruit or collection of seeds can be clearly demonstrated. Explain that unless the seed is steeped before sowing, the seedlings have difficulty in breaking through the husky skin.

IV. VEGETABLE PRODUCTION Contd.

BRASSICAS

Brassicas, or members of the cabbage family, are all derivatives of the wild cabbage, *Brassica oleracea*, which is indigenous to the south coast of Britain. They form a very important section of vegetables. In winter few other fresh vegetables are available. At other seasons they form a vital link in the year's vegetable succession. It is possible to have brassicas all the year round, and in the school garden this should certainly be done. As there is no common cultural factor, it will be necessary to treat the various kinds separately.

Spring cabbages.—Sow in a sunny seedbed in late July or early August. Mix with each square yard 2 oz. of freshly slaked lime when forking a foot deep. Broadcast the seed thinly, and just cover it by light raking. When the seedlings are forming their third rough or normal leaf, transplant them 6 in. apart into rich nursery beds, where they will grow strongly, and form a healthy fibrous root system before the final planting.

The final planting.—Undertake this in early October, while the soil is still warm enough to ensure re-establishment before winter. Incorporate no farmyard manure, which makes growth too succulent to survive hard frost. A cleared potato plot forked one foot deep is excellent for spring cabbages without the addition of any fertiliser. Plant at an all-round distance of 9 in. apart, thinning to 18 in. in March. In view of the risk of casualties, it is prudent to take this extra cover.

Winter treatment. Give monthly dressings of weathered soot to warm the soil and ward off slugs. Hoe regularly. Earth up to the bottom leaves with finely pulverised soil, and during hard weather cover the plants with dried bracken or straw.

Bolting and feeding. Bolting is the premature formation of flower spikes. The first symptoms are marked lengthening of the main stem. Immediately they are observed, pierce the stem an inch above the soil level, and insert a piece of match stalk or a pebble into the slit. This check arrests bolting, Fig. 53. In early March stir into the soil around each plant ½ teaspoonful of

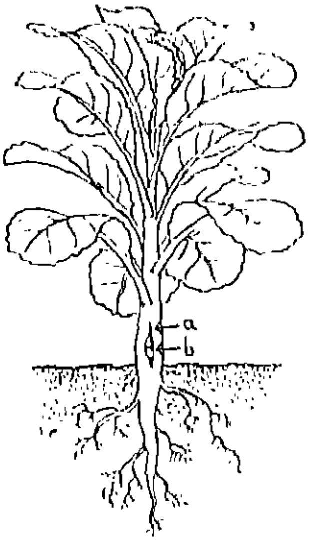


FIG. 53. DIAGRAM SHOWING BOLTING SPRING CABBAGE AND HOW TO ARREST BOLTING

a. Pierced stem.
b. Pebble in pierced stem.

nitrate of soda, a readily available nitrogenous fertiliser, to stimulate growth.

Summer cabbages.—These should be sown on a hotbed or in a heated greenhouse in early February. Use 2½ in. deep boxes; at the bottom of each place an inch layer of rough leaves for drainage. Then fill up fairly firmly to within ½ in. of the top with a riddled mixture of loam 3 parts, leaf mould and sand one part each. After levelling the surface with a flat board, water through a rosed can with boiling water, to destroy weed seeds, soil grubs, and microscopic enemies. As soon as the soil cools, distribute the seed thinly and evenly on the surface, and cover, first with glass, and then with brown paper, to maintain stable conditions during the germination period, Fig. 54.

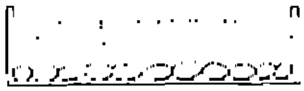


FIG. 54. SECTION THROUGH SEED BOX PREPARED FOR SOWING SUMMER CABBAGES AND CAULIFLOWERS

Transplanting.—When the seedlings are forming their third normal leaf transplant them 2 in. apart into other boxes, adding one part of well-rotted manure to the compost advised for seed sowing. Use aired water for watering, to avoid a check. Continue hotbed or greenhouse treatment until early April, when the seedlings should be gradually hardened off in readiness for planting in their final quarters by the middle of that month.

The final planting.—Provide rich, deeply dug soil. This section of the cabbage, having no hard weather to face, can and should be stimulated to grow vigorously. Plant alternately at an all-round distance of 18 in. apart. Earth up as far as the bottom leaves when the plants are half grown, and from this stage until they are ready for cutting feed fortnightly with dilute liquid manure, giving each plant 4 pints per dose. This fertiliser is primarily nitrogenous, and as cabbages are grown for the sake of their leaves, is appropriate.

Autumn cabbages.—Early April is the time for sowing these, under precisely the conditions described for the spring section. Transfer the plants to nursery beds at the same stage of growth, before they become overcrowded, plant them 2 ft. apart in rich land. Cabbages grow more vigorously in autumn, hence the need for more space, and also the wisdom of not feeding with liquid manure.

Brussels sprouts.—This crop should be sown under glass in February, according to the method indicated for summer cabbages. Transplant into boxes also, and after careful hardening off, into the final quarters in mid-May.

The preparation of the soil.—The soil must be most carefully prepared. Mock trenching is advisable, and ¾ pailful of good stable manure should be mixed with each square yard of both 1 ft. layers. In addition, rake into each square yard 2 oz. of superphosphate of lime. The phosphates in this fertiliser are needed to balance the nitrogen in the stable manure. Without them the buttons or sprouts are spongy, the plants lose their bottom leaves, and are long-jointed. In addition, tread medium and heavy soils very firmly. Roll light ones. More than usual firmness is necessary to prevent over exuberant growth.

The final planting and feeding.—Space the plants 30 in. apart, setting them alternately to make the maximum use of space. Water generously in dry weather. During July, August, and September, hoe into the plot, at ten-day intervals, a 1 oz. per square yard dressing of superphosphate of lime. As autumn approaches, support each plant with a neat stake, to prevent the wind causing root strain.

Summer cauliflowers.—The seed of this crop should be sown under glass in February, the seedlings transplanted into boxes, and from them into final quarters in April in the manner indicated for summer cabbages.

The preparation of the soil.—Summer cauliflowers are the tenderest members of the cabbage family, hence it is imperative to select a warm, sunny site for them. It should be mock trenched, and each square yard of both 1 ft. layers dressed with ½ pailful of good farmyard manure.

After treatment and feeding.—Owing to the tenderness mentioned, summer cauliflowers sometimes cease growth during cool spells. To stimulate them, water each plant with 2 pints of a solution prepared by dissolving one ounce of sulphate of ammonia in a gallon of water. The lethargy departs instantly. From the time the plants are half grown until the heads are ready for cutting, feed every ten days with an equal part mixture of superphosphate of lime and sulphate of potash, hoeing it in at the rate of 1 oz. per square yard. Immediately the curds form, protect them by covering them with the inner circle of leaves broken at the middle.

Autumn cauliflowers.—Sow this crop as suggested for autumn cabbages. Accord similar nursery bed treatment, and transplant into the final positions before overcrowding arises.

The preparation of the soil.—Follow the lines described for summer cauliflowers but plant 2 ft. apart. Make the soil firm, as this crop does not finish until late autumn, and must therefore, be encouraged to develop sturdy growth. Feed as suggested for summer cauliflowers.

Autumn heading broccoli.—This is a hardy strain of cauliflower. It comes into season immediately after autumn cauliflowers, but takes longer to mature. Hence the seed should be sown at the same time. In all other respects the crop should be treated in a similar way. In fact, if autumn cauliflowers and autumn broccoli were grown alternately on the same plot, both would do well.

Winter heading broccoli.—A crop that should be grown only in the mildest districts, and even then there is some risk of curd damage. Sow in early May under conditions similar to those suggested for spring cabbages. After going through the nursery bed stage, the crop is ready for its final positions at the end of June or early July.

The preparation of the soil.—An unusual method is adopted for mid-winter broccoli. The site should be mock trenched. Mix with each square yard of bottom layer ½ pailful of littery farmyard manure. Mix no organic manure with the top layer, but rake in a 2 oz. per square helping of steamed bone flow to supply in late autumn the phosphates which firm the growth. The object of this special method is to encourage the crop to root deeply, so that when the cold weather comes, and the top layer is frozen the roots can still go on absorbing from the bottom layer, and feeding their curds. Beyond earthing up as far as the bottom leaves, no other treatment is necessary.

Late heading broccoli.—This crop follows the winter section. Sow the seed in mid-May, and transplant before congestion arises in the nursery beds, into quarters prepared on the pattern outlined for the mid-winter section.

Heeling over.—A process which protects the crop from frost damage. Take out a spadeful of soil on the north side of each plant. Push the main stem into the hole, and desposit the soil on the south side. Thus the plants face north, a position which at first sight appears to afford the minimum instead of the maximum protection. Actually

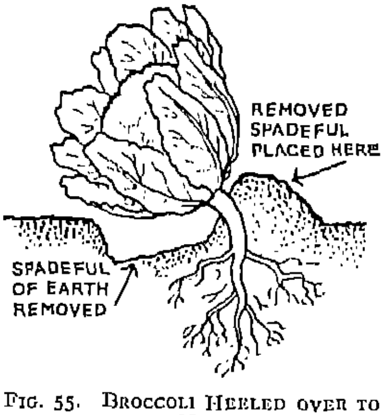


Fig. 55. Broccoli Heeled over to the North

the maximum is provided. When plant tissues freeze, the sap leaves the cells, and collects as icicles on the cell walls. If the thaw is rapid, as it is when the sun shines directly on the frozen parts, the cells cannot re-absorb the melting icicles. When the thaw is slow, as it is in this case, the cells are able to take back their contents, and growth proceeds normally, Fig. 55.

Early and late savoys.—Sow seed of the former in early April, of the latter in early May, and treat both crops as advised for autumn cabbages.

Borecole or curled kale.—Treat exactly as suggested for late savoys.

Purple sprouting broccoli.—Treat as advised for early savoys.

USEFUL HINTS

Blind plants.—Examine a typical seed or nursery bed of spring cabbages, where a small proportion of blind plants is sure to be seen. They possess no growing point, and are, therefore, incapable of making further progress. The children should be taught to recognise these plants at sight, and of course they must not be planted, Fig. 56.

An experiment.—Leave a few seedlings in the summer cabbage seed bed, and at the final planting time compare the root system with that of seedlings transplanted into a nursery bed. The obvious superiority of the latter will impress the need for the nursery bed phase of culture, Figs. 57 and 58.

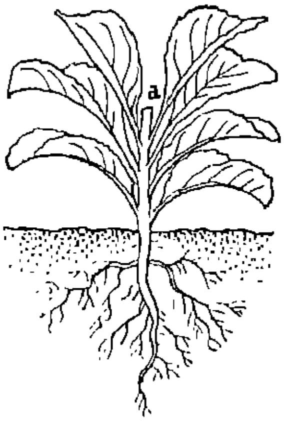
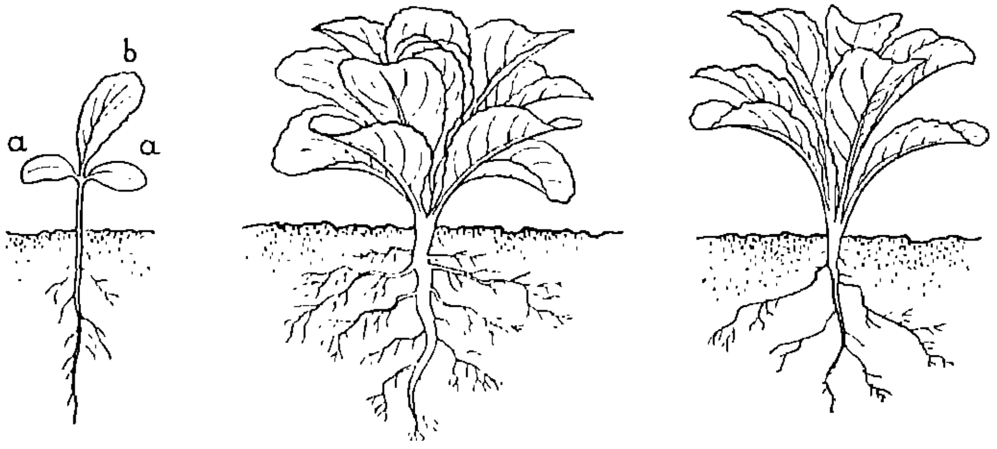


Fig. 56. A "Blind" Brassica

a. Aborted growing point.

The normal leaf.—Explain that every seedling brassica has two first formed rudimentary leaves known as cotyledons or seed leaves. They emerge from the seed. The first leaves that form after these are known as the normal leaves, Fig. 59.

Seed sowing in boxes.—Point out that manure is not mixed with the sowing compost



Figs. 57 to 59. Planting Cabbages

A seedling brassica.
a. Cotyledons, or seed leaves.
b. First normal leaf.

A well-rooted summer cabbage, the result of planting in a nursery bed.

A sparsely rooted summer cabbage, the result of remaining in the seed bed.

because the pungent ammonia gases that proceed from it would injure the germinating seedling.

Clean seed boxes.—Before sowing, each box should be thoroughly brushed out, and if necessary dipped in boiling water to cleanse it. Unless the boxes are clean, moulds arise from them, spread into the compost, and destroy the young roots.

"Woolly" cauliflowers.—These are cauliflowers which are past their prime. The curds, instead of being white and closely set, grow out like small sponges, and become discoloured. Point out that cauliflowers very soon pass out of condition, hence it is advisable not to grow more than can be used within two or three weeks.

CLASSROOM WORK

The origin of brassicas. Discuss the origin of brassicas. The cabbage was raised by selecting superior types of the wild cabbage, the Brussels sprout by selecting plants which developed their axillary leaf buds. Cut open a cabbage, and show that those leaf buds are present in the axil of every folded leaf, but that they remain undeveloped. Savoys are cabbages with crinkled leaves that fold in and form a heart. *Curled kales* are *cabbages* with crinkled leaves which do not form hearts. Cauliflowers and heading broccoli are cabbages which develop malformed inflorescences or flower clusters, while purple sprouting broccoli are cabbages that develop short side shoots.

Kind of Crop	*Period of Sowing*	*Season of Use*
Spring cabbage	End July or early August	April and May
Summer cabbage	Early February*	June and July
Autumn cabbage	Early April	September to November
Brussels sprout	Mid-February*	October to March
Summer cauliflower	Early February*	July and August
Autumn cauliflower	Early April	September and October
Autumn heading broccoli	Early April	September and October
Late heading broccoli	Mid-May	April to June
Early savoy	Early April	October to December
Late savoy	Early May	January to March
Borecole	Early May	November to March
Purple sprouting broccoli	Early April	January to May
White sprouting broccoli	Early April	January to May

FIG. 60. BRASSICA SUCCESSION TABLE
The mark * indicates that the plants must be sown under glass.

All these types have been raised and improved by isolation, and careful seed saving indicates that the cabbage family is very liable to sport or depart from type, hence there may yet be valuable additions to it.

The brassica succession.—Prepare a chart showing how to maintain a twelve months' succession of brassicas, Fig. 60. (See page 30.)

Labels.—As all seed beds, nursery beds, and crops in final quarters should be labelled, an opportunity should be made to prepare and write labels in the classroom. Use seasoned deal. Make each label 7 in. long, point it at the base, smooth and paint the writing surface, and on it inscribe the name as shown in Fig. 61.

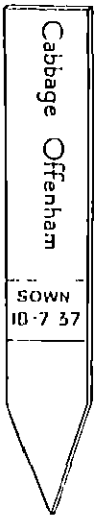
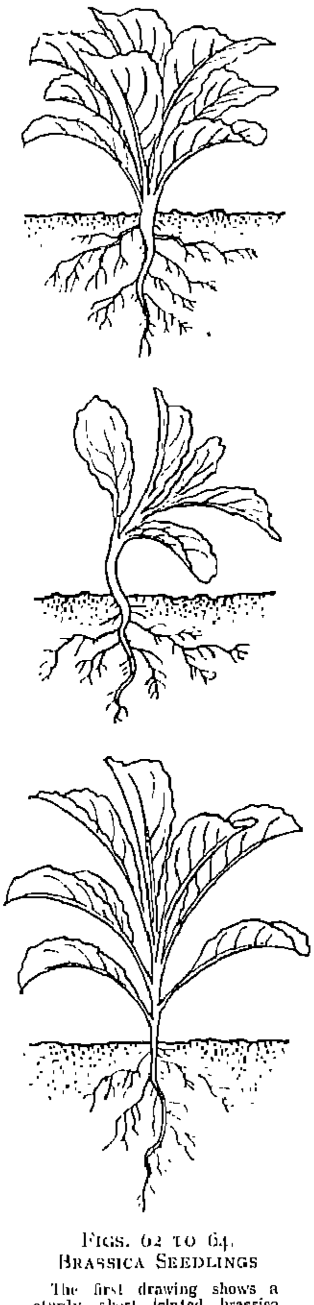


FIG. 61.
PLANT
LABEL

Seedling selection. Seedling brassicas are very variable. Some are long jointed, some bent stemmed, others sturdy and short-jointed. The two first named types are undesirable. Imperfect fertilisation, or seed-sowing under unsuitable conditions, may be the cause. They must be rejected. Bring the various types into the classroom, and let the children prepare drawings of them to fix in their minds an impression of desirable and undesirable types, Figs. 62, 63 and 64.



FIGS. 62 TO 64.
BRASSICA SEEDLINGS

The first drawing shows a sturdy, short jointed brassica seedling (desirable).

The next drawing shows a bent stemmed brassica seedling (undesirable).

The bottom drawing shows a long jointed brassica seedling (undesirable).

Saving brassica seed. Purchase a good cauliflower or cabbage, cut out of the centre a triangular piece of stem 1 in. long, and plant it in good soil in a clean, well-drained 5 in. pot. Stand the pot in a light window, water normally, and in a few weeks flowering side shoots will emerge. Just before the buds unfold, enclose the inflorescence in a muslin veil to exclude insects which might introduce foreign pollen. When the seed is ripe, extract it, store it in a cool, dry drawer and sow at the appropriate time.

V. VEGETABLE PRODUCTION—Contd.

POD-BEARING CROPS

Broad beans.—There are two sections of broad beans, Longpod and Windsor. The former is characterised by hardiness and heavy yields, the latter is much tenderer, and the yields are considerably lighter. The Windsor varieties, however, possess a much superior flavour.

Preparation of the soil.—This should be on generous lines, as broad beans root deeply. An ideal method is to form 2 ft. deep trenches. Take out the soil in 1 ft. layers, keeping them separate. When returning the bottom layer, mix one pailful of littery farmyard manure and 2 oz. of crushed bones with each yard run. Mix a similar quantity of well-rotted manure and bone meal with each yard run of top layer. Break up the soil finely, and press it fairly firmly.

Seed sowing.—Longpod broad beans may in mild districts be sown in November, thus forwarding the gathering date by about three weeks. In cold districts, however, nothing is gained by autumn sowing. February is the better time. Take out 9 in. wide, 3 in. deep, flat-bottomed drills, setting two rows of seed alternately in each, at an all-round distance of 6 in. apart. Place a few extra seeds in a reserve border to fill up gaps in the rows and replace defective plants. Sow Windsor varieties under precisely similar conditions from mid-April to the end of May, Figs. 65 and 66.

Early attentions.—As soon as the seedlings appear, protect them from birds, and apply a 1 oz. per yard run dressing of superphosphate of lime to accelerate root action. When the plants are 6 in. tall, draw up to each side of them a 3 in. high bank of finely pulverised soil, to steady the stems, conserve moisture, and encourage surface rooting. When the plants are in flower, tap the stems lightly daily to distribute the pollen. When flowering ceases, remove the growing point of each plant to concentrate nutriment in the developing pods.

Feeding.—From the time the first flowers fall until the last pod is gathered, feed weekly with superphosphate of lime at the rate of 1 oz. per yard run of drill. Stir the fertiliser in if the soil is moist, water if it is dry. Phosphates expedite the development of seed, hence their value as a fertiliser for broad beans.

French beans.—These are sometimes called kidney beans on account of the shape of the seed. Being natives of South America, they must not be sown until the danger of severe frost is past. The pods must be gathered before the seeds start to swell, as these greatly depreciate culinary value. The preparation of the soil should be similar to that suggested for broad beans.

Position and seed sowing.—Choose a sunny, warm site, otherwise the flowers will drop prematurely, and growth be weak. Set the seed in 9 in. wide, 2 in. deep, flat bottomed drills, two rows in each, at an even distance of 6 in. apart. Deep sowing is fatal, because in the cooler conditions the seed rots, or the seedlings grow deformed. Mid-May is

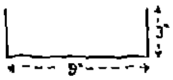


FIG. 65.
SECTION THROUGH BROAD BEAN DRILL

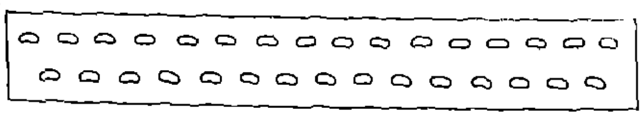


FIG. 66. PLAN OF BROAD BEAN DRILL, SHOWING ALTERNATE ARRANGEMENT OF SEEDS

suitable for the first sowing, early June for a succession batch.

Early attentions.—When the seedlings are 6 in. tall, water each with 2 pints of a solution prepared by dissolving ½ oz. of sulphate of ammonia in a gallon of water. This readily available nitrogenous fertiliser gives growth a fillip, and is a sure safeguard against the semi-chlorosis or pale-leaf by which this crop is sometimes embarrassed. If the plants become too leafy, remove a few of the inside leaves to allow air to reach the flowers and pods.

Feeding.—After the pods are 1 in. long, feed weekly with quarter strength liquid manure (one gallon per yard run of drill) until the crop is finished. This fertiliser, being primarily nitrogenous, suppresses the seed and emphasises the development of the pods, which are leafy structures.

Runner beans.—These, like French beans, are tropical, their native habitat being Mexico.

Preparation of the soil.—This must be on most liberal lines, as runner beans have vigorous growth to support. Take out a 15 in. wide, 2 ft. deep trench. With each yard run of bottom 1 ft. layer mix 1½ pailfuls of littery stable manure and 4 oz. of crushed bones. Mix a similar quantity of well-rotted manure and bone meal with each yard run of top layer. Break up the soil finely, and return the layers in their original position. Choose a warm, sunny site, not exposed to high winds from any quarter, otherwise the crop, when in full growth, may be badly damaged.

Seed sowing.—At the centre of a 6 in. wide, 2 in. deep drill sow one row of seed at 9 in. apart. Before filling in, fix by the side of each bean an 8 ft. tall stake, securing the stakes with a row of cross pieces. Staking must be done at this juncture, as the roots will be damaged if stakes are pushed in later. Sow in late May or early June.

Early attentions.—When the seedlings are 6 in. tall, feed with the sulphate of ammonia solution indicated for French beans. If the growing point is disinclined to twine, wrap it gently round the stake. Should dry weather prevail when the plants open their first flowers, water copiously, or the petals will drop without setting beans. In early July mulch 12 in. on each side of the row with a 2 in. layer of well-rotted manure, to feed a little, but mostly to conserve moisture.

Feeding.—When the first pods are 2 in. long, feed with quarter strength liquid manure (2 gallons per yard run), repeating at weekly intervals until the end of the season.

Peas.—Peas are a very important crop. It is possible, by regulating the sowings, to have them in season from mid-May until late October. There are three sections, first earlies, second earlies, and maincrops. Make the first sowing of first earlies in early March, another sowing the third week in March. Then follow two sowings of second earlies at fortnightly intervals. Afterwards sow maincrops at three-weekly intervals until early June.

Preparation of the soil and seed sowing.—Prepare the soil exactly as advised for broad beans. Draw 9 in. wide, 3 in. deep, flat-bottomed drills. In them space the seed of all varieties 2 ft. tall and less, at 3 in. apart. Allow 3½ in. between the seed of varieties 2 to 4 ft. tall, 4 in. between that of 4 to 6 ft. tall kinds. Overcrowding must be scrupulously avoided.

Early attentions.—Protect the seedlings from birds as soon as they appear, and when they are an inch tall, apply sulphate of ammonia at 1 oz. per yard run to deepen the green of the foliage and accelerate growth. When the tendrils show, support the plants, using bushy tree branches pointed at the base. If branches of average spread are spaced a foot apart, and the openings at the base are filled in with twigs, there will be adequate support with no light obstruction—an important matter. The height of the branches must be 6 in. greater than that of the variety concerned, and all varieties, however dwarf they are, must receive some support. When the plants finish flowering, nip out the growing points, to assist the swelling of the seeds.

Feeding.—Operate on precisely the lines advised for broad beans. No fertiliser is equal to superphosphate of lime for filling the pods to the maximum.

USEFUL HINTS

Direction of seed drills.—Seed drills should run north and south to ensure maximum benefit from sunshine. In the morning the sun shines on the east side of the drill, at noon the light is evenly distributed, in the afternoon the west side gets a special share.

Protection of seeds.—Immediately before sowing pea and bean seeds soak them in paraffin for three minutes, afterwards rolling them in red lead as a safeguard against attack by rats and mice.

Bone meal for pod-bearing crops.—This fertiliser, which is mainly phosphatic, is of special value to pod-bearing crops because it helps them to develop their seed. Stress this point when preparing the soil.

Suckering broad beans.—The broad bean is a branching plant, but better yields are obtained when the basal side shoots or suckers are removed when 2 in. long. The energy of the plant is then concentrated into one stem, instead of being spread out over many, Fig. 67.

Alternative method of staking peas.—Where tree branches are not available, stakes and string may be used as shown in the accompanying diagram. Wherever possible, obtain tree branches, as the tendrils cling better to natural wood, Fig. 68.

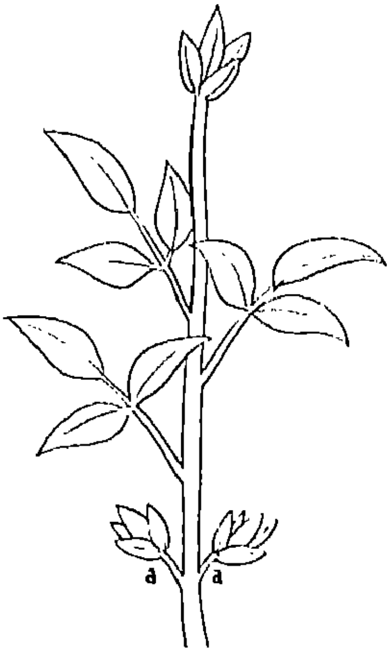


Fig. 67. Broad Bean Plants, showing Suckers

a. Sucker, to be removed when 2 ins. long.

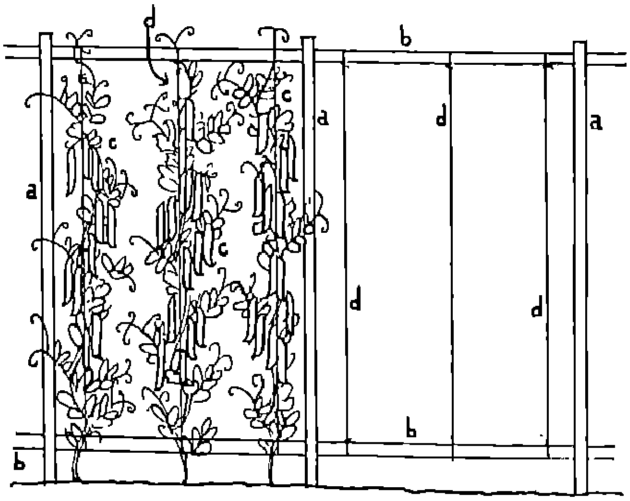


Fig. 68. Stake and String Method of Supporting Peas

a. Upright stake.
b. Cross stake.
c. Plant growing round string.
d. String.

Dwarfing runner beans. Where stakes are unobtainable for runner beans, or the garden is very exposed, the plants can be dwarfed. When they are a foot tall, remove the growing point of each. Follow a similar course with any of the resulting side shoots which straggle. In this way bushy, heavy-yielding plants develop.

Frost damage to runner and French beans.—The first autumn frosts damage the foliage unless the position is sheltered. As this first frost may be followed by two or three weeks of mild weather, it is extremely unfortunate if runner and French beans in full bearing are cut off. This can be prevented by spraying the plants copiously with cold water, thus inducing a slow thaw, and gradual resumption of normal activity.

CLASSROOM WORK

Pea root nodules. Pull up a pea plant and show it to the class. Explain that the nodules or swellings on the roots were first formed, and are inhabited by bacteria, which have the power of bringing the free nitrogen of the atmosphere into combination. Some of it is used by the peas, and some is passed into the soil. Thus the latter is always richer in nitrogen when peas are pulled up than it was when they were planted. The bacteria, microscopic organisms, derive their nutriment from the peas yet the association is wholly beneficial, Fig. 60.

Culture solution. Place broad bean seeds in a culture solution. Watch their development, and through it explain the phenomenon of germination. A seed might be dissected and the various parts shown. The following is an excellent culture solution: water 5 pints, potassic nitrate 15 grains, calcic sulphate 25 grains, magnesic sulphate 25 grains, calcic phosphate 25 grains, sodic chloride 25 grains, sulphate of iron a trace.

Examine broad bean seed.—Examine broad bean seed which is to be sown in the garden. If there are small holes in it, the Bean Weevil is or has been feeding on the reserve material. To make sure of destroying any insects that may be present, sprinkle the seeds lightly with tobacco powder, and place them in a closed tin box until next day.

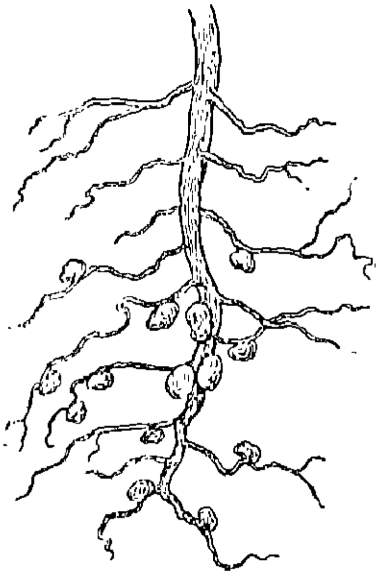


FIG. 60. ROOT OF A PEA PLANT, SHOWING NITROGEN NODULES

Pea sowing board.—It is rather a slow business sowing peas and measuring the distance between them. This work will be speeded up if sowing boards are made. Bore through ¾ in. deal, holes large enough to allow the pea seed to drop through. The board is placed in the drill, and the seeds are dropped through it. Three sets of boards will be necessary for the three sections, the holes to be 3, 3½, and 4 in. apart respectively.

VI. VEGETABLE PRODUCTION—Contd.

SALADS, CELERY, LEEKS, AND VEGETABLE MARROWS

Salads possess valuable health-giving properties. Their food value is not great, but the vitamins they contain are highly eulogised by the medical profession. Provision should be made to grow a representative collection in the school garden. The common cultural need is uninterrupted growth. Ensure it by working the soil thoroughly to a depth of 1 foot, and mixing a light dressing of leaf mould or well-rotted farmyard manure with the soil. If dry conditions obtain, water thoroughly, or the check inflicted by drought will spoil the food value of the salad concerned.

Lettuce.—There are two sections of lettuce, round or cabbage, and cos. Cabbage varieties are sown at intervals of three weeks from mid-March until mid-August, the last sowing passing the winter out of doors, and maturing the following May. Cos varieties may be sown in April for cutting in August, or in August for cutting the following spring. Broadcast the seed in a reserve plot, and when the seedlings are forming their third normal leaf, transplant them 6 to 12 in. apart into permanent quarters. The actual spacing is governed by the height of the variety.

Radishes.—There are two sections, long and round. The former resist cool conditions well, but are not equal to forming succulent roots in hot, dry weather, hence they are sown at three-weekly intervals from the end of February until the middle of May. Round radishes do not withstand cold successfully, but are excellent drought resisters, hence sowings of them take up the running from mid-May until the end of August. The seed should be broadcasted thinly, the only subsequent attention needed, being thinning out if overcrowding is evident.

Onions.—This crop is often grown solely as a salad. If sown in August, the young plants are ready for pulling from January onwards. From March to July sow at monthly intervals to maintain a succession, under similar conditions to those suggested for radishes.

Corn salad or lamb's lettuce.—This is a lettuce-like plant which does not form a heart. Sow at fortnightly intervals from early March until early July, in 1 in. deep drills spaced 6 in. apart. Thin the seedlings to 6 in., and when the crop is ready for use, gather the leaves separately, on each occasion reducing the pick to one or two leaves per plant, to ensure continued growth.

Mustard and cress.—These two salads are taken together because they are used together. As cress develops more slowly than mustard, it should be sown three days before. From early April until mid-August broadcast the seed thickly at three-weekly intervals. Water freely to accelerate growth. Cut the salads before the rough leaf forms. Only the seed leaves are palatable.

Chicory and broad-leaved dandelion.—These two crops are grown for the sake of their branched leaves. Sow in early May in 1 in. deep drills set 1 ft. apart. Thin the seedlings gradually to 12 in. asunder, and when the rosettes attain a respectable size, gather them together, tie them loosely, cover each plant with an inverted pot or box, and use the leaves when they are quite white.

Celery and leeks.—The essentials of success with celery, a crop grown for the sake of its blanched leaf stalks, are to keep growth moving and to provide very rich soil. Any check in development, however slight, almost invariably results in bolting or the premature formation of flower spikes.

Seed sowing.—Mid-February is the best period. Artificial heat is necessary. Where there is no heated greenhouse, a frame on a hotbed provides ideal conditions. Use 2½ in. deep seed boxes, and a riddled compost of loam 3 parts, leaf mould and sand 1 part each. At the bottom of the boxes place a 1 in. layer of the rough compost riddlings, afterwards filling up fairly firmly to within ½ in. of the top with compost. Level the surface, water through a rosed can with boiling water to destroy harmful soil life, and as soon as the soil cools, sow thinly. Cover the seed with silver sand, and the boxes, first with glass, then with brown paper, to maintain equable conditions during the germination period.

Transplanting into boxes.—When the seedlings are forming their third normal leaf, plant them 2 in. apart into similar boxes, adding one part of well-rotted manure to the ingredients suggested for seed sowing. Continue hotbed or greenhouse treatment, watering freely all the time, until early May, when the seedlings should be hardened off gradually in a cold frame.

The preparation of the trenches.—Wherever possible this work should be done the previous winter, to give the soil a chance to weather. An appropriate width is 18 in. Take out the soil to the depth of 2 ft. At the bottom place a 2 in. layer of leaf mould, to help to conserve soil moisture. Now return 6 in. of subsoil, mixing with each yard run a pailful of strawy stable manure. Follow with the surface soil, filling the trench to within 3 in. of the top. With each yard run of top layer mix a pailful of well-rotted manure, pressing the soil firmly. Arrange the surplus soil in the form of a neat bank or ridge alongside the trench, Fig. 70.

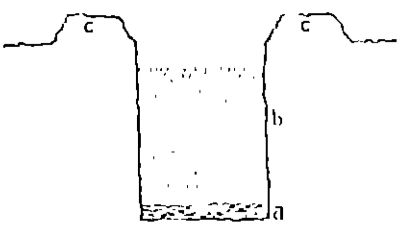


FIG. 70. PREPARED CELERY AND LEEK TRENCH

a. Leaf mould layer.
b. Prepared soil.
c. Ridge formed by superfluous soil.

Planting out.—Lift the seedlings carefully from moist soil, and plant them 9 in. apart, setting them opposite to avoid complications at earthing time. Take care not to bury the deeply sunken growing point, or the plants will perish.

Feeding.—In early July begin feeding. Use half strength soot water (one gallon per yard run) and agricultural salt solution, (½ oz. in a gallon of water and a gallon per yard run) weekly and alternately until the end of September. Celery is of maritime origin, hence the value of salt.

Earthing up.—Earthing up with finely pulverised soil is done to blanch the stems. It is a gradual process beginning early in September, when a 4 in. layer of soil is packed neatly round the plants. Other 4 in. layers should be added at fortnightly intervals until everything but the leaves is covered. Before earthing, remove the small outer leaves and the side shoots that their removal reveals.

Leeks.—Very few separate observations are necessary. Seed sowing, transplanting into boxes, planting in final quarters, the preparation of the trenches, and earthing up are conducted on exactly similar lines as for celery. Feeding, however, is with quarter strength liquid manure, of which weekly doses at the rate of one gallon per yard run should be given from mid-July until the end of September.

Vegetable marrows, like runner and French beans, are of tropical origin, hence they must not be placed in an outdoor environment until the end of May.

Seed sowing.—There are two methods. One is to sow the seed separately in 3 in. pots in late March, on a hotbed or in the greenhouse. Use the compost advised for celery sowing. Continue protected treatment until mid-May, when the seedlings should be gradually hardened off in a cold frame. The other method consists of sowing the seed out of doors in late May. Obviously the first named gives an earlier yield, but often two batches are sown to provide a succession over the longest possible period.

Preparations for outdoor sowing and planting.—Select a sunny, warm situation. If the manure heap is in such a situation, form on top of it, at intervals of a yard apart, 9 in. wide, 6 in. high, mound-shaped heaps of a compost of loam 4 parts, leaf mould, well-rotted manure and sand 1 part each.

Outdoor sowing and planting.—At the centre of each mound sow two seeds ¼ in. deep and 2 in. apart. Water through a rosed can. Place a bell glass or inverted glass jam jar at the centre of each mound, to assist germination and protect the seedlings in their very early stages. Later remove the weaker of the two seedlings. Set one indoor-raised plant at the centre of each mound.

Stopping.—At the formation of the seventh or eighth leaf remove the growing point of each plant, to induce a branching habit. When the fruits are swelling on the side shoots, remove the growing point of each side shoot one leaf beyond the fruit. Follow this course to the end of the season. The object of training growth in this way is to induce maximum fruitfulness, and reduce the area covered. If no stopping were done, the plants would spread tremendously and most of the growth be sterile.

Feeding.—From the time the first fruits are the size of a tennis ball until the end of the season, feed weekly with dilute liquid manure, giving each plant one gallon per dose.

Top-dressing.—When white roots appear through the surface of the mound, cover the latter with a 2 in. layer of the compost advised for planting and sowing. This may be necessary three or four times during the season.

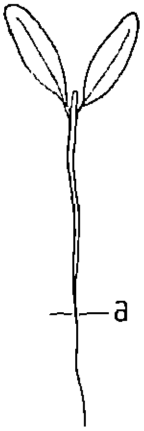


FIG. 71. SEEDLING LETTUCE

a. Cut tap root here before transplanting.

USEFUL HINTS

Cutting lettuce tap root.—The great difficulty of persuading lettuce to form firm, nutty hearts is overcome by clipping ½ in. off the base of each tap root immediately before planting. The check administered prevents over-exuberance, Fig. 71.

Hotbed radishes.—Radishes can be grown quite successfully all the year round if a hotbed is provided for their cultivation at periods when it is impossible to grow them out of doors. To maintain a succession, sow at three-weekly intervals. Broadcast the radishes thinly on a 4 in. deep bed of good soil formed on top of the manure, Fig. 72.

Mustard and cress in boxes. Mustard and cress might be grown in boxes in school. Sift some garden soil, place a few leaves at the bottom of 2½ in. deep boxes, fill the latter firmly to within ½ in. of the top, sow the seed thickly on the levelled surface, cover the boxes with boards, and stand them in a warm position. When the seedlings are 1 in. tall, remove the boards, afford plenty of light and moisture, and the salads will be ready for cutting a few days after sowing.

Celery and leek trench ridges. Indicate that owing to the elevated situation, with its greater warmth, celery and leek trench ridges are ideally adapted for the quick growth of salad crops. They should be used for this purpose until the soil is needed for earthing the celery and leeks.

Planting celery and leeks.—Very often celery and leeks must be planted in hot, dry weather. Sunshine causes them to droop badly. To prevent this, place a few pea or bean sticks across the ridges for a few days

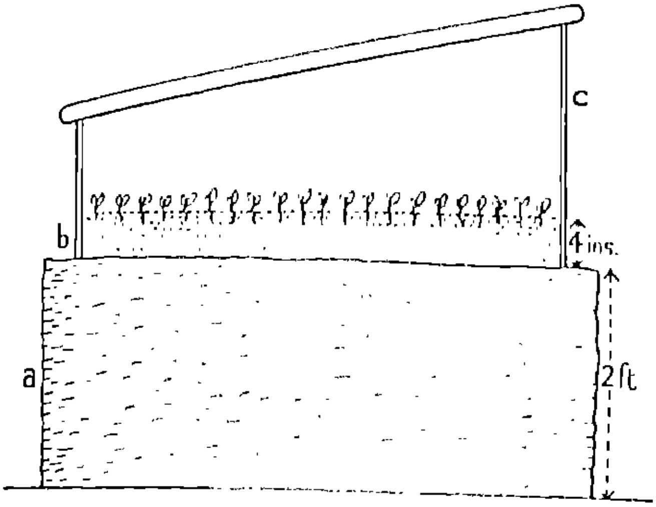


FIG. 72. RADISHES ON HOTBED

a. Hotbed.
b. 4 in. deep bed of soil.
c. Garden frame.

until the plants recover from the transplanting check, and are able to stand up on their own.

CLASSROOM WORK

Chicory and celery blanching. When light is excluded from celery and leek stems the green colouring matter disappears. This makes the stems more acceptable from the culinary standpoint. Explain to the children how chlorophyll is formed, and what it does.

Steep celery seed. Prepare a formaldehyde solution, one medicinal drachm of commercial formalin in 2½ pints of water. Steep the celery seed in it for three hours, stirring every hour. Taking the seed out, dry it slowly in a cool place. This treatment, now universally adopted, is designed to destroy Leaf Spot Disease, a serious malady which is transmitted from the seed coat.

Pollination of marrows.—Bring to the classroom the two types of marrow flower, and demonstrate pollination. Remove the petals from the non-marrow-bearing bloom, and gently push the exposed core, bearing pollen, into the centre of the marrow-bearing flower. Bees may perform this office in the garden, but are by no means certain to do so, hence pollination is a gardener's duty, Fig. 73.

Sow marrows in pots.—This work might well be done in the classroom. Place one crock or potsherd at the bottom of each of the required number of 3 in. pots. Cover the crock with a little rough compost, and after filling to within ½ in. of the top with fine compost, dibble in the seed ½ in. deep.

An alternative method of celery and leek blanching. Soil is not necessary for celery and leek blanching. Paper collars can be used. They are valuable in heavy soil, being less liable to stain the stems. The collars are made of corrugated paper, each being 4 in. wide and 9 in. long. The collars are wrapped round the plant and tied with raffia. They might be made in the classroom.

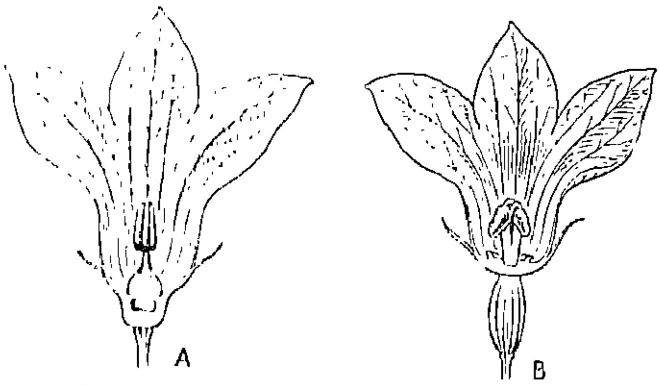
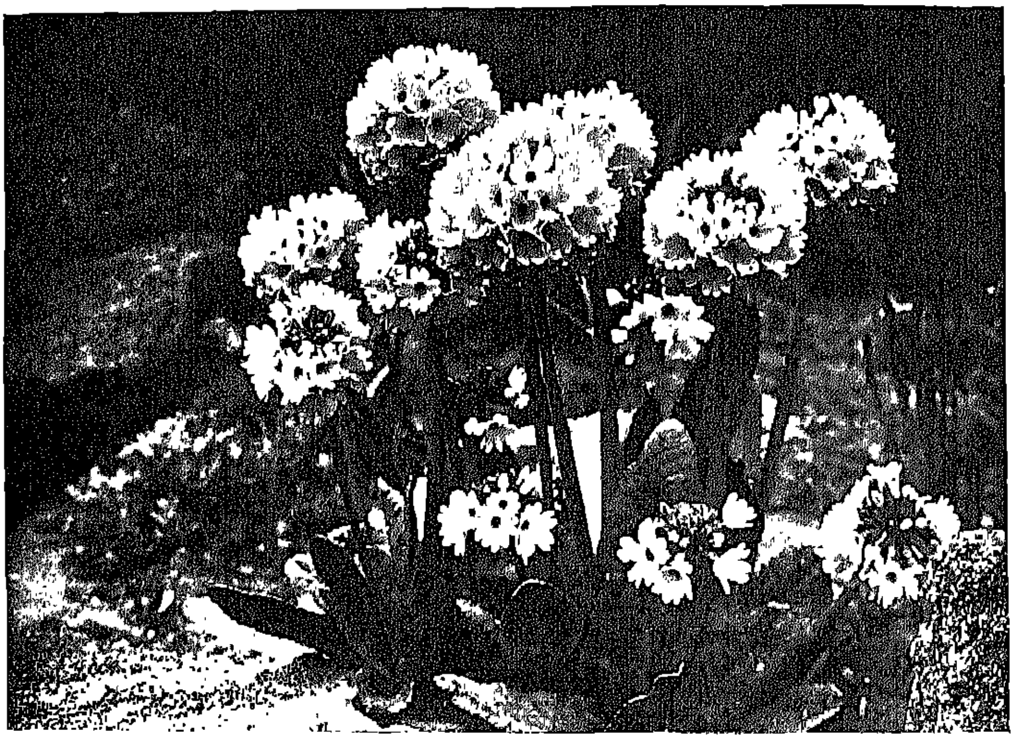


FIG. 73. FLOWER OF VEGETABLE MARROW PLANT

A. Section through a male flower, which has stamens and pollen but no stigma or fruit.
B. Section through a female flower, which has stigma and fruit but no stamens.

SECOND YEAR COURSE

VII. PROPAGATION—SEED SOWING, STEM AND ROOT CUTTINGS, LAYERING



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PRIMULA JAPONICA

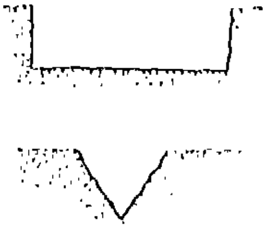
Seed sowing.—A seed is an entirely new generation. It represents the union of the generative nucleus of a pollen grain with the egg cell in the ovum. Diseases are not transmitted by this process, hence a seed is entirely healthy. It is, therefore, except in the circumstances to be mentioned later, the most desirable means of propagation.

Condition of seed.—Unless seed is harvested when properly ripe, and under good weather conditions, it will not germinate. Sowing must take place within a reasonable period of harvesting, or the embryo will perish, or lose its vitality.

Period of seed sowing.—This must be carefully considered in relation to each kind of seed. Generally speaking, winter sowing is unsuccessful.

Preparation of outdoor seed bed.—For successful germination, the soil must be reduced to the finest possible condition to the depth of 1 ft. As a rule, winter digging precedes seed bed formation. The soil is already partly tempered. Complete the process by forking 1 ft. deep, and breaking the lumps with the back of the tines. Now tread the surface moderately, and follow by raking it perfectly even. Depressions have an adverse influence on soil temperature, and on the efficient distribution of moisture.

Drill sowing.—Many kinds of seeds, such as peas, beans, wallflowers, sweet peas etc., are sown in drills which are formed with a swan-necked draw hoe. As a preliminary, stretch a line tightly, and with the corner of the hoe in the case of a V-shaped drill, and with the full width of the blade in that of a flat-bottomed drill, take out the soil to the required depth. Work the hoe with a series of jerks rather than with long pulls. Always draw the drills from the same side of the line when working through the garden, otherwise spacing arrangements will be faulty. Broadly, large seeds are sown in flat-bottomed drills, small ones in the V-shaped type, Figs. 74 and 75.



FIGS. 74 AND 75. DRILLS.

The top drawing shows a flat-bottomed drill for large seeds. The lower drawing shows a V-shaped drill for small seeds.

Broadcasting.—The seed bed is prepared as advised above, and the seed scattered on the surface. Afterwards it is covered by light raking. This method is desirable for subjects such as radishes, mustard and cress, and clumps of hardy annuals, because it makes a more economical use of the ground. Overcrowding should be relieved later by thinning. Broadcasting is also desirable for small seeds which, as seedlings, occupy the ground but temporarily. In this category fall members of the cabbage family, herbaceous perennials, polyanthuses, primroses, double daisies and so on. At an early stage they are transplanted to nursery beds, and from these into the permanent quarters.

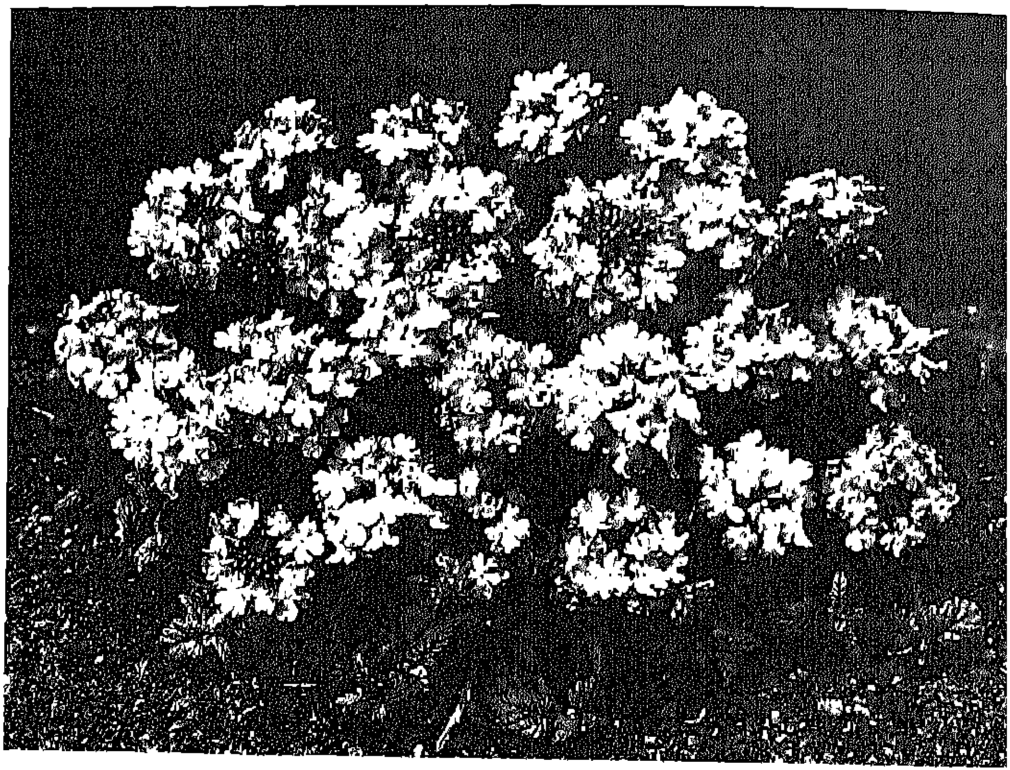
Condition of soil for seed sowing.—No attempt should be made to form a seed bed in wet or frosted land. In the former case it is impossible to break down the lumps, and when the soil dries out, it sets like iron. In the latter the temperature remains depressed for months.

Seed sowing under glass.—Conditions under glass are more artificial than those outdoors, hence more care is essential. The fate of outdoor seedlings must to a large extent be left to the elements. The fate of indoor batches rests with the cultivator.

Receptacles.—Boxes 2 ft. long by 1 ft. wide and 2½ in. deep are admirable. They hold just the right quantity of soil to sustain healthy seedling growth. Where these boxes are too large for the purpose, flowerpots or seed pans, shallow earthenware vessels, may be used as a substitute. It is highly essential that all receptacles shall be scrupulously clean, or strangling, root-destroying moulds may be transmitted to the seedlings. As a precautionary measure dip the vessels in boiling water an hour or two before sowing.

Compost.—The following is ideal for seed sowing:—loam 3 parts, leaf mould and sand 1 part each. Manure must not be used at this stage, as the ammonia gases arising from it greatly embarrass young roots. Pass the ingredients through a ½ in. sieve, to ensure fineness and evenness of texture.

Preparations for seed sowing.—Drain the receptacles thoroughly, the boxes by placing a ½ in. layer of compost riddlings at the bottom, the pots and seed pans by placing at the bottom a single layer of convexly placed crocks, or potsherds, covered with a ¾ in. layer of rough riddlings. Now fill up fairly firmly to within ½ in. of the top, and level the surface of the compost with a firming board. Water through a rosed can with boiling water, to destroy harmful



VERBENA [*Reproduced by courtesy of Sutton & Sons, Ltd*

microscopic organisms and weed seeds, Figs. 76, 77 and 78.

How to sow.—Open the seed packet at one corner, distribute the seed very thinly, and just cover it with silver sand or finely sifted compost. Very tiny seeds, such as those of the herbaceous calceolaria, can be distributed evenly by mixing them with an equal quantity of white flour. Another excellent plan for sowing very small seeds is to sprinkle them on an odd piece of glass and then brush them on to the soil with the pointed end of a label (letting the mitre lie flat on the glass). Cover the boxes first with a sheet of glass, then with brown paper, to maintain equable conditions of temperature

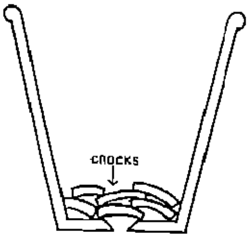


FIG. 76.

Flowerpot correctly drained. Note the convexly placed crock

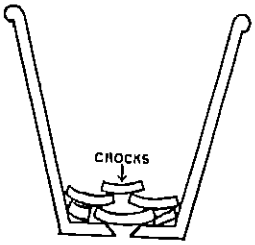


FIG. 77.

HOW TO FILL A FLOWERPOT

Flowerpot incorrectly drained. Note the concavely placed crocks.

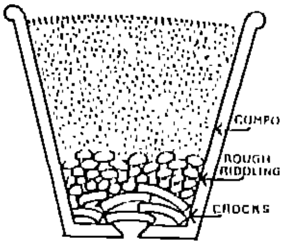


FIG. 78.

Flowerpot correctly filled for seed sowing.

and moisture during the germination period. Stand the vessels in a draught free corner of the greenhouse or hotbed.

Later treatment. Examine the boxes daily. Turn the glasses if beads of moisture collect on them, otherwise conditions will become much too wet. Immediately the seedlings appear, remove the covers, and afford good, but not too intense light for a few days. An excellent method is to prop a little muslin or newspaper over the seedlings during the brightest periods, to prevent the sun scalding their tender tissues. Water carefully, using aired water applied through a bent nozzled syringe or a very fine rosed can.

Transplanting. This operation consists of removing the plants from the seed vessels to other quarters, which may be boxes or a cold frame, when they are forming their second or third rough or normal leaf. On no account must overcrowding be permitted, or the seedlings will spindle. Water the day before transplanting, to avoid root disturbance on lifting. Lift with a spatula or flat, pointed stick. Separate the seedlings carefully, and with a dibber set them 2 in. apart, with the seed leaves resting on the soil. The after treatment, of course, depends on the kind of seedlings, Fig. 79.

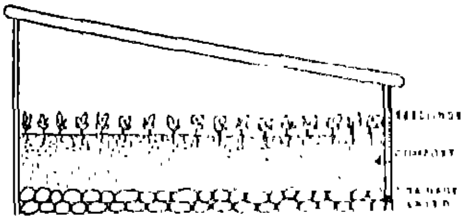


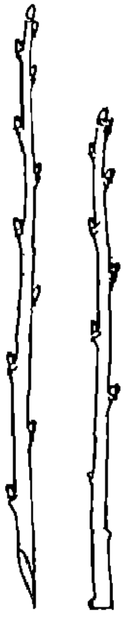
Fig. 79. Seedlings Transplanted into Cold Frames

Stem cuttings. The stem cutting is a vegetative method of propagation adopted with a wide variety of plants, which can either be raised more expeditiously in this way than from seed, or which do not come true from seed.

Hardwooded stem cuttings. As the name indicates, these cuttings are taken from hard wood, after leaf fall in the case of deciduous kinds, because the evaporation from the leaves reduces the rooting chances. Evergreen hardwooded cuttings must, of course, be taken with the leaves on, but in this case evaporation is so slow as to exercise no adverse influence. Examples of subjects that can be raised from hardwooded cuttings are gooseberries, black and red currants, flowering currants, mock oranges, privet, and cherry laurel.

The insertion of hardwooded stem cuttings.—November to March is the period, the earlier the better, as the cuttings are then able to form roots before spring drought arises. Detach healthy, 9 to 12 in. long shoots in the case of leaf shedders, 4 to 6 in. in that of evergreens. Prepare the leaf shedders by cutting the stem across immediately beneath the bottom joint, and removing the dormant leaf buds from the bottom half of the cutting. Prepare evergreens by removing the leaves from the bottom 2 in. of stem, and shaving the latter across immediately beneath a joint. Plant cuttings of leaf shedders half their depth, of evergreens 2 in. deep, both in a sandy, well-worked border.

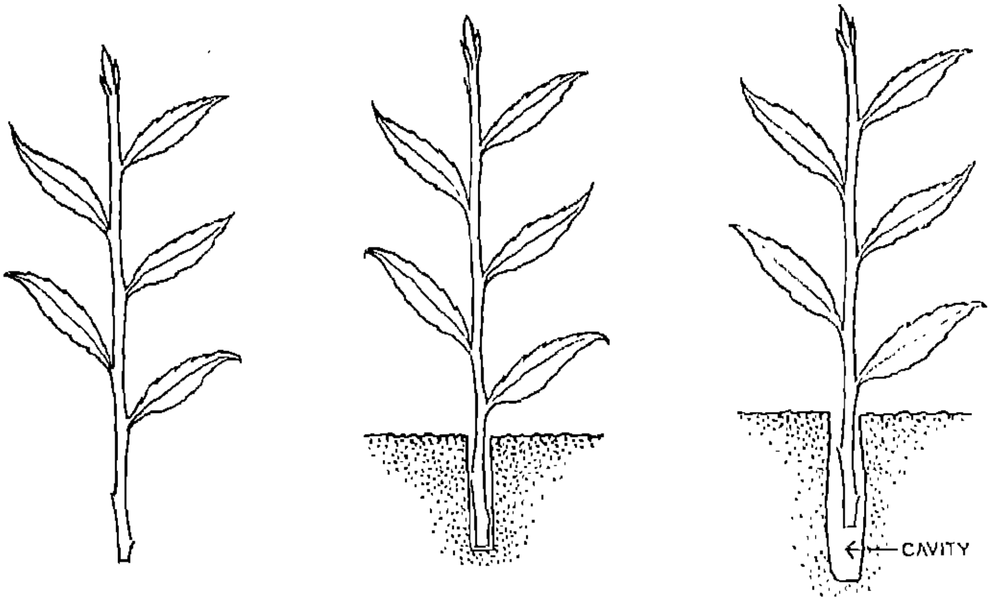
Later treatment.—Little is necessary in this respect, but during winter any cuttings that are lifted by frost should be replaced promptly otherwise they will perish through lack of soil contact. Stir the cutting bed regularly with a hand fork, and if water lodges on the surface, cover it with a ½ in. layer of sand. Twelve months elapse before cuttings of this type are ready for transplanting, Figs. 80 and 81.



Figs. 80 and 81. A Hardwooded Stem Cutting

The left-hand drawing shows the cutting, while the right-hand drawing shows the cutting prepared for insertion. Note that the dormant leaf-buds have been removed from the bottom half of the stem which is cut across horizontally.

Succulent stem cuttings.—These cuttings are sometimes called soft wooded, but the term succulent is preferable, as there is no woody tissue about them. They are, as the name indicates, succulent shoots taken from plants that respond to propagation in this way. The number is legion. Examples of greenhouse plants are geraniums, fuchsias, chrysanthemums, and petunias; of outdoor plants, violas, pansies, calceolarias, pentstemons, nepeta, phloxes, and helianthemums.



Figs. 82, 83 and 84. The Insertion of a Stem Cutting

From left to right the drawings show:—
A succulent stem cutting prepared for insertion. Bottom leaves removed, and stem cut horizontally just beneath bottom joint.
A stem cutting correctly inserted. Cutting base touches bottom of hole.
A stem cutting incorrectly inserted. Note the cavity beneath the base of the cutting.

Choice of cutting.—Choose a perfectly healthy 2 to 2½ in. long shoot. In the case of variegated plants, avoid those that are running back to the green, and in that of flowering plants, those that have exhausted themselves by flowering.

Preparation of the cutting.—Remove the leaves from the bottom inch of stem, using a penknife to avoid skin peeling. Shave the stem immediately beneath the bottom joint. Dip the cuttings in weak nicotine insecticide to destroy the green fly and other insect pests that are often found feeding on them, Figs. 82, 83 and 84.

The insertion of succulent stem cuttings.—Chrysanthemums are taken as the type of greenhouse cutting. Root them in well-drained, 3½ in. pots, setting four equidistant round the side of each pot. Use a riddled mixture of loam 3 parts, leaf mould and sand 1 part each. After filling the pot to within ½ in. of the top, spread on the surface of the compost a ¼ in. layer of sand, to maintain porosity and stimulate rooting. Plant the cuttings firmly with a dibber, afterwards watering through a rosed can, and standing the pots in the propagation frame.

Violas are taken as a type of cutting which is inserted in a cold frame. Spread at the bottom of the frame a 2 in. layer of rubble for drainage. On this form a 4 in. deep bed of the compost advised above. After levelling the surface, cover it with ¼ in. layer of sand, and plant the cuttings firmly 2 in. apart. Water them thoroughly through a rosed can, and keep the frame closed for two or three weeks, until the appearance of young growth signifies that roots have formed.

Helianthemums are taken as a type of cutting which is inserted out of doors. Choose a sunny border, fork 1 ft. deep, secure a texture of seed-bed fineness and firmness, plant 2 in. apart, water thoroughly, and repeat whenever the soil dries.

Time to insert succulent cuttings.—The period is not as definitely fixed as it is with hardwooded cuttings. As a matter of fact, succulent cuttings can be inserted in a greenhouse at any period of the year, though spring is the principal season. Out of doors, the majority of these cuttings are inserted between early April and the end of June, so that they can become established while the weather is good. Most frame cuttings are planted in early autumn, to give them a chance to root before winter.

Root cuttings.—Only a limited number of plants are increased in this way—seakale, hollyhocks, anchusas, statice, aralias, and oriental poppies. These plants do not form suitable stem cuttings, hence the need to adopt the alternative method.

Preparation and planting of root cuttings.—Lift a healthy plant at any period from March to November, when the sap is flowing freely. Wash the roots under a running tap. Cut up into 2 in. long pieces those roots that are about the thickness of an ordinary lead pencil. Thinner or thicker roots do not make suitable cuttings. With a penknife nick the apex of each cutting, to make sure of planting the right way up. Plant the cuttings 2 in. apart in 2½ in. deep boxes prepared as suggested for seed sowing. Leave just the apex of the cutting exposed. After watering, stand the boxes in a cold frame, or in the greenhouse propagating frame. Very soon a callus will spread over the top. On this, crowns or dormant shoots are found, and ultimately growth develops. As soon as it does, the now rooted plants must be transferred to other quarters, and given the treatment peculiar to their kind.

Layering.—A layer is a shoot which is rooted while still attached to the parent. Plants that are propagated in this way derive benefit from the parental connection. Food is continually being passed to them, and this aids the rooting process. The following are examples of subjects that are increased by layering:—carnations, gypsophilas, rhododendrons, cherry laurel, rambler roses, and clematises.

The preparation of the layer.—The border carnation is taken as the type. In July, when there is an abundance of healthy young shoots, strip the leaves from the bottom inch of stem of the number required for layering. In the stripped part form a slit 1 in. long. Pass the knife blade through the outer skin. Let it pass to the centre of the stem, afterwards carrying it upwards. It is very important that this procedure shall be followed. A pierced slit is not enough, because it so quickly heals, making it impossible for roots to form. To make sure that the tongue or loose strip of stem does not close, work a small pebble behind it. Figs. 85 and 86.

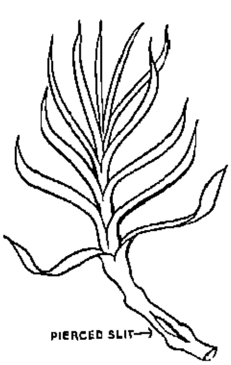


FIG. 85. CARNATION LAYER SHOWING PIERCED SLIT—AN INCORRECT METHOD

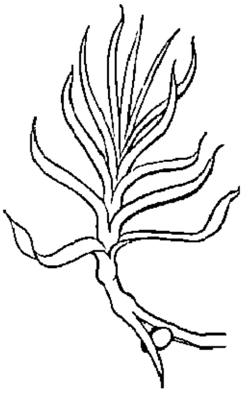


FIG. 86. CARNATION LAYER CORRECTLY PREPARED

Planting the layers.—Form around each plant, extending a little beyond the outer shoots, a 4 in. high mound of sandy soil. In this, plant the layers carefully, spreading them out as much as possible to avoid damping off through overcrowding. Afterwards straddle each layer stem with a pothook-shaped, galvanised wire peg, or a wood peg. The latter is the better, as carnation growth does not take too kindly to contact with metal. The object of pegging down is to prevent movement of the layer, which would be fatal to rooting. These attentions completed, water through a rosed can, and repeat as often as necessary until the layers are transferred to their permanent quarters, Fig. 87.

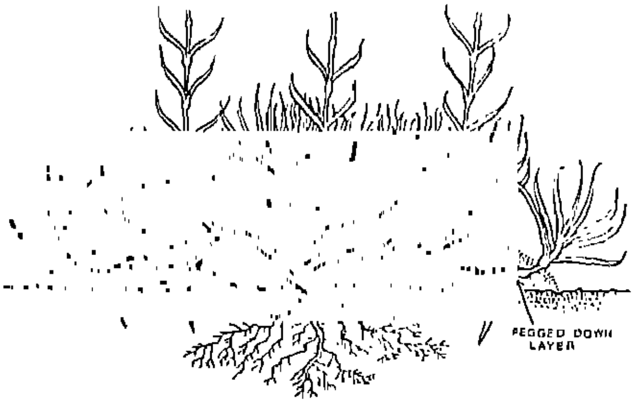


FIG. 87. LAYERED CARNATION PLANT, SHOWING SOIL MOUND AND PEGGED DOWN LAYERS

Planting in permanent quarters.—About mid-September the layers will show, by forming young growth, that they are rooted. They should then be detached from the parent by clipping the connecting stem immediately outside the soil mound. Three days later, lift the now rooted plants carefully, with a nice ball of soil attached to their roots, and plant them 1 ft. apart in the sunny, rich beds which carnations love. On no account sever the layers and transplant simultaneously. Both operations impose a check. Obviously it is better that both should not fall at the same time.

General data.—The layering process, as described above for carnations, applies in principle to every plant that can be propagated in this way. Naturally the rooting period varies, but can always be determined by the development of young growth. Thus a year may elapse before a woody subject such as the rhododendron becomes an independent plant. The judgment of the gardener must be used on this point.

USEFUL HINTS

The germination of seed.- For successful germination, heat and moisture are necessary. The first stage is the absorption of moisture, which causes the embryo to enlarge and the seed coat or testa to burst. Ferments operate inside the embryo, quickening it into activity. The root emerges first, and is followed by the cotyledons or seed leaves. Generally speaking, no seed will germinate when the soil temperature falls below 41° F.

Forking the seed bed.—Firmness is essential to ensure capillarity and an even moisture condition. When seed is sown in spongy land, it is subject to violent extremes of dryness and moisture, which frequently destroy the embryo. Hence the need for treading before sowing.

Seed compost ingredients.—The loam used in seed composts is taken from the top few inches of a good pasture in a partially decayed condition. The more fibre there is about it, the better, as this contains both humus and food. Leaf mould is decaying forest tree leaves. When preparing the compost, sticks, stones, and other alien material should be removed from the leaf mould. Silver or river sand should be used to ensure porosity. Any kind of red sand is unsuitable, on account of its harmful iron content.

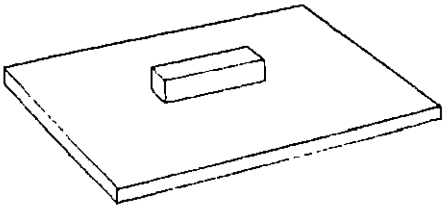


FIG. 88. FIRMING BOARD, FOR FIRMING COMPOST IN SEED VESSELS

Nursery beds.—This phase in the cultivation of seedlings that are not sown in their permanent quarters is highly important. It induces the formation of abundant fibrous roots, without which the subjects concerned cannot succeed.

Cuttings of variegated plants.—Most variegated plants produce albino or entirely white shoots. As these contain no chlorophyll or green colouring matter, they should not be inserted, for they cannot live.

Manure in cutting compost.—Farmyard manure should not be mixed with cutting composts, because on decay it liberates acids, which inhibit rooting. An abundance of sand should always be used.

CLASSROOM WORK

Sun scorch.—Place a seedling growing in a flowerpot under a bell glass or large glass jar. Sprinkle the leaves with water, and stand the plant in a sunny window. Very soon rusty blotches will develop beneath the beads of moisture. The sun has acted on those beads like a burning glass, scorching the tissues beneath.

Preparation of deciduous cuttings.—Deciduous or leaf--shedding cuttings are inserted in autumn at half their depth. Before insertion, the leaf buds on the bottom half of the cutting should be removed carefully, with a sharp knife, otherwise they will grow into sucker shoots, and make it impossible properly to train the subject concerned.

Internodal cutting.—In no instance does an internodal cutting root as successfully as one of the nodal type. In most cases the former dies. Demonstrate both types clearly, explaining that the cambium is more active at the joints or nodes, hence the callus that precedes rooting is more easily formed, Fig. 89.

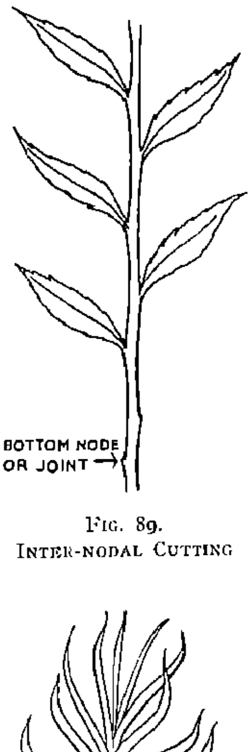


FIG. 89. INTER-NODAL CUTTING

Carnation layer.—In preparing carnation layers it is easy to make the fatal mistake of exposing the pith when removing the leaves. The latter clasp the stem, and if they are dragged off, only the pith is left behind. Such layers never root. Great care must, therefore, be taken when stripping the leaves, Fig. 90.

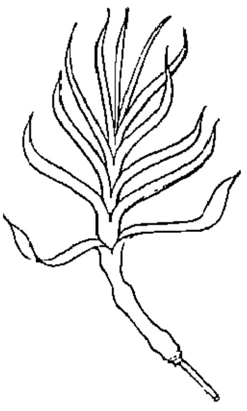


FIG. 90. CARNATION TOO DRASTICALLY STRIPPED, SHOWING PITH. INCORRECT METHOD

Depth of sowing.—Fill four flower pots with soil. In one sow carrot seeds 3 in. deep, in others sow carrot seeds an inch deep.

Water the pots whenever they need it. Note that the shallowly sown seed germinates in a few days, whereas that sown 3 in. deep rots in the soil. Conduct a similar experiment with peas, sowing 3 in. and 5 in. respectively. Explain that sowing depths are governed by the size of the seed, 1 in. being a good average for small seeds, 3 in. for larger ones.

Unclean receptacles.—Place under a microscope the scrapings from the inside of a dirty flowerpot. Note that a large number of organisms appear in the field. With few exceptions these are harmful to plant life. While the memory of what has been seen is fresh, impress upon the children the need for sowing in clean vessels.

VIII. PROPAGATION (Continued)—BUDDING, GRAFTING, ROOT DIVISION

Budding.—Budding is an operation which consists of uniting parts of two plants to ensure a better flowering or fruiting habit, and a longer and more certain life. The parts concerned are the root, which is known as the stock, and a dormant leaf bud, known as the bud. It is essential that the partners shall be closely related botanically, otherwise it is impossible to secure an effective union between the two. It would, for example, be useless to try budding a rose on to a mock orange, or a plum on to a sycamore. With few exceptions, the partners should belong to the same Natural Order. Subjects that are increased by budding are tea, hybrid tea, hybrid perpetual, and climbing roses; apple; pear; plum; cherry; peach; nectarine; holly; azalea; and rhododendron.

The stock.—In all cases the stock is carefully chosen, because it provides the root system, and imparts flowering or fruiting qualities over a long period to the shoots resulting from the bud. The roots of subjects that are budded do not possess these qualities, and are, moreover, liable to die suddenly from no apparent cause. Suitable stocks for the subjects mentioned above are:—(1) *roses*,—the native dog rose, *Rosa canina*; (2) *apple*,—Paradise for bush, crab for standards; (3) *pear*,—quince for bush, seedling pear for standards; (4) *plum*,—common plum for bush, Mussle for standards; (5) *cherries*,—Mahaleb for bush, Morello for standards; (6) *peach*,—(all types of tree) Mussle; (7) *nectarine*,—(all types) Mussle; (8) *holly*,—common holly; (9) *azalea*,—Azalea pontica; (10) *rhododendron*,—Rhododendron ponticum.

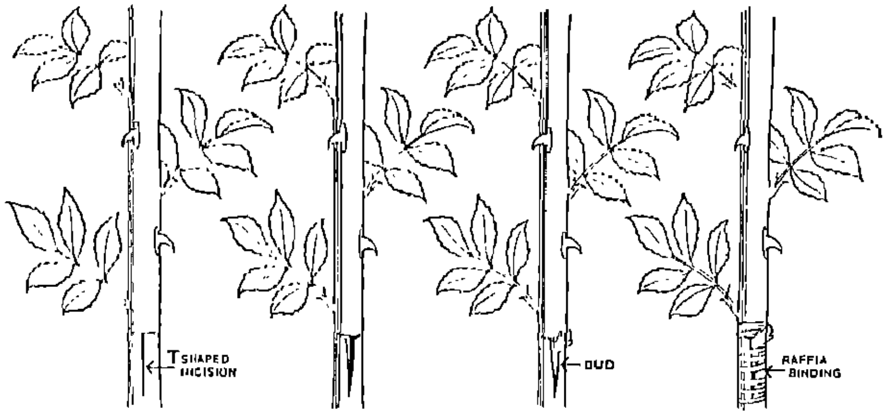
Stocks must be planted at least twelve months before budding, or they will not be sufficiently established to promote union.

The bud.—This represents the variety which it is desired to perpetuate. A dormant leaf bud is removed at a time when the sap is running freely, and inserted in the stock.

Union of stock and bud explained.—In both stock and bud there is interposed between the xylem and the phloem a highly protoplasmic layer of cells known as the cambium. To this layer belongs the function of uniting the two partners. The cambium in one links up with that in the other. Afterwards the united layer carries on the normal functions of cell division. As the bud forms the growing point, it is that which extends, and in its extension reveals the characteristics of the variety budded. Though complete union takes place, and the two partners work together as one self-contained organism, neither loses its specific characteristics. The stock is always a stock, the variety always a variety.

The budding of dwarf roses.—Now that general principles have been enunciated, the propagation of dwarf roses will be described fully to make clear the practical side of the operation. Mid-July is the best period, because at that season the sap is running so freely that complete union is only a matter of a few hours.

The preparation of the stock.—The stock is, of course, in full growth, and must not at this stage be pruned beyond what is necessary for the insertion of the bud. The more leaves there are, the more energetic is the sap flow. With a sharp knife, preferably a budding knife, make a T-shaped incision in the most vigorous stem at the ground level. The vertical stroke of the T should be 1¼ in. long. The cross stroke should pass half way round the stem. When making the cut do not pierce the pith, only the outer skin, which afterwards should be loosened and pressed gently back, Figs. 91, 92, 93 and 94.



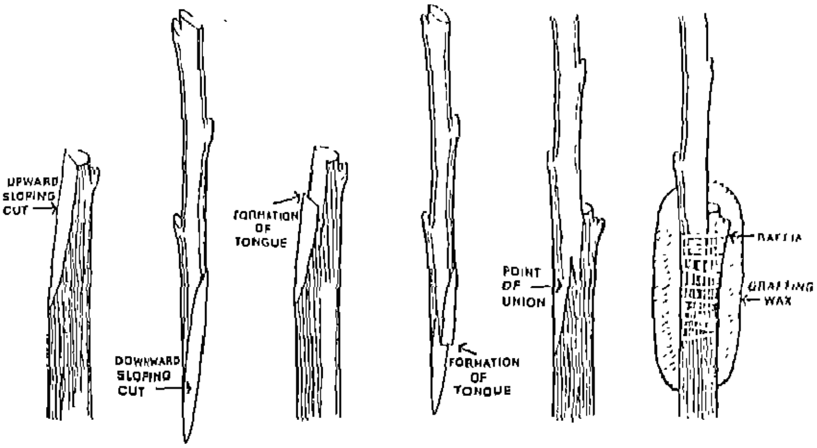
FIGS. 91 TO 94. GRAFTING

From left to right the diagrams show:—
A dwarf rose stock showing T-shaped incision.
A dwarf rose stock with skin round the incision pushed back ready for the insertion of the bud.
The bud inserted in the T-shaped incision.
The T-shaped incision and the inserted bud are bound with raffia.

Taking the bud.—The best dormant leaf buds occur in the leaf joints of half ripened shoots of the current year. They can be seen very clearly. To remove them, first cut off the attendant leaf to within ¼ in. of the base of the leaf stalk. Now pass the knife blade through the skin ½ in. below the bud. Pass it upwards behind the bud, and bring it out ½ in. above. The skin that comes away with the bud is known as the shield. If it does not come away cleanly, trim it. Turn the bud over, and if any pith is visible, remove it most carefully, as this would prove an insurpassable obstacle to union. Occasionally the actual bud is left behind, and only a skin envelope removed. When this is so, the place where the bud should be is empty, and another must be taken.

The insertion of the bud.—Speed is vital in this part of the operation. The cambial layer is ultra delicate, and if exposed to the air for more than a very short time, will perish. Then, of course, the chances of union are wiped out. At the beginning, when the hand is not very supple and skilful, it is a good plan to keep the buds fresh by dropping them into a saucer of water. Handle each bud carefully with the forefinger and thumb of the right hand, and work the shield behind the previously raised skin. Make sure that the bud is right side up, otherwise the resulting shoot will grow down-hill for a time, and must, if it is to be of any use, turn a somersault. If it does not break its back in doing so, the rose tree will be deformed. After insertion, wrap the T-shaped incision fairly tightly with a single layer of moist raffia, leaving the bud exposed. In forty-eight hours it will be possible to tell whether union has been effected. If it has, the bud will still be fresh and green and no fears need be entertained on its behalf. If it is black and withered, insert another bud at the opposite side of the stem, or in another stem of the same stock.

Later treatment.—Beyond swelling a little, the bud will make no further progress until autumn or the following spring, when it will grow out into a well-defined shoot. If the growth occurs in autumn, it will be very succulent, and should be protected by wrapping a hay band round it during very severe weather. At the end of March, when the new season's growth starts, cut off every part of the stock except that which lies beneath the shoot. Then the variety is in full possession of the field. During the first year it is known as a maiden rose. Afterwards it becomes a fully fledged rose bush. Usually the raffia ligature bursts as the stem swells. If it doesn't, remove it when cleaning off the superfluous parts of the stock.



FIGS. 95 TO 100. WHIP AND TONGUE GRAFTING

From left to right the diagrams show:—
First stage in the preparation of stock.
First stage in the preparation of the graft.
Second stage in the preparation of the stock.
Second stage in the preparation of the graft.
The stock and graft united.
The stock and graft bound.

Grafting.—Grafting is a very old art. The object of the operation is precisely similar to that of budding—to unite a superior root stock with a variety of fruit or flower to give it longer life and greater fruiting or flowering qualities. With the exception of roses, which are not grafted, all the subjects which are budded may be grafted also, and the same stocks are used. The stock in this case is, however, united with a shoot instead of a bud. The shoot is known as the graft or scion.

The best period for grafting.—The sap must be flowing freely, but it is not advisable to graft when the scion is in full leaf. The rate of transpiration through the leaves would greatly reduce the chances of union. Late March or early April is the best time, because the sap is then very active, and the leaf buds, though ready for bursting, are still within their scales.

The grafting of a bush apple.—The bush apple is taken as the type because the stock and scion unite fairly easily, and the fruit is grown in most school gardens. Remove the graft from the tree of the variety it is desired to propagate three or four months before the operation, and bury it in moist soil in a shady situation to make sure that the sap is not quite as active as in the stock. When there is this slight difference, union is more certain. The ideal graft is a 9 to 12 in. long, one year old shoot, approximately equal in diameter to that of the stock.

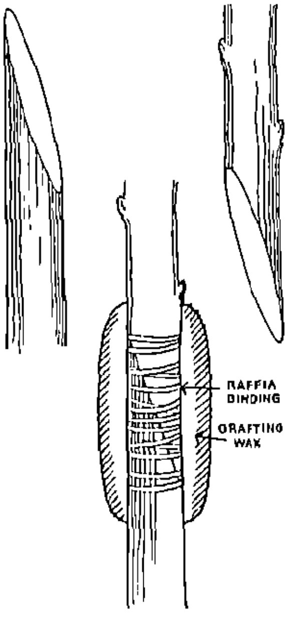
The preparation of the stock.—Immediately before grafting, cut down the stock to within 6 to 9 in. of the ground level. If there is more than one stem, choose the best, and cut off the others, to eliminate competition. There are various methods of grafting, which will now be described separately.

Whip and tongue.—Make an upward, sloping cut about 1 in. long at the top of the stock, and in the middle of the slope make a $\frac{1}{8}$ in. deep, wedge-shaped incision, known as the tongue. At the base of the graft make two corresponding cuts, so that stock and graft can be spliced and held together by fitting the tongues into each other, Figs. 95 to 100.

Splice.—Make an upward, 1 in. long sloping cut at the top of the stock. At the base of the graft make a similar cut, and fit the two together. This is not quite as good as the whip and tongue method, because obviously there is a risk of the graft slipping, making union impossible, Figs. 101, 102, 103.

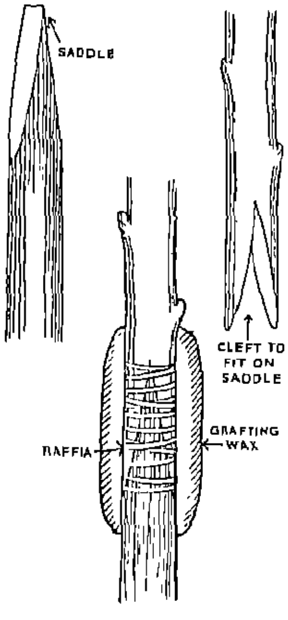
Saddle.—The term suggests the method. The top of the stock is cut to the shape of an inverted V. An inverted V-shaped cut is also made into the base of the scion. The latter is fitted into the former, Figs. 104, 105 and 106.

Somerset saddle.—The only difference between saddle and Somerset saddle grafting is that a little flange is left at the base of the graft cut, as an additional safeguard against slipping, Figs. 107, 108 and 109.



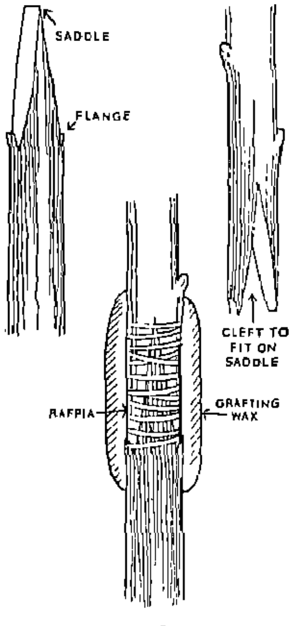
FIGS. 101, 102 AND 103.
SPLICE GRAFTING

The top left-hand illustration shows the stock prepared for the graft.
The top right-hand drawing illustrates the graft prepared for the stock.
The lower drawing shows the stock and the graft united.



FIGS 104, 105 AND 106.
SADDLE GRAFTING

The top left-hand drawing shows the preparation of the stock.
The top right-hand drawing shows the preparation of the graft.
The lower drawing shows the stock and graft united.



FIGS. 107, 108 AND 109.
SOMERSET SADDLE GRAFTING

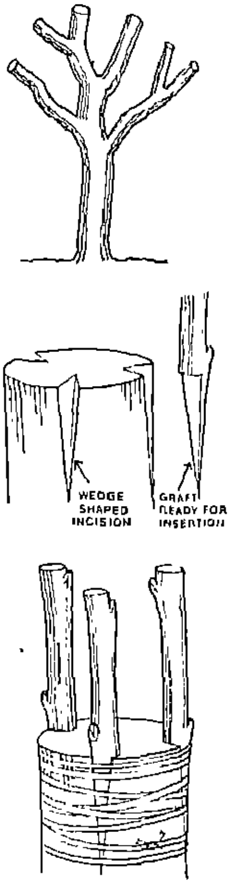
The top left-hand drawing illustrates the preparation of the stock.
The top right-hand illustration shows the preparation of the graft.
The lower drawing shows the stock and the graft united.

Binding graft and stock.—Immediately after fitting graft and stock, bind the two fairly tightly with moist raffia, covering the cut parts. Follow by covering the raffia with ½ in. layer of grafting wax, to ensure stability, and keep out air, which is fatal to union.

Later treatment.—Two or three months after grafting, remove the wax and the raffia. Stock and graft are then united, and the tree is a maiden tree, to be shaped by pruning.

Regrafting.—Sometimes orchard trees become useless on account of severe pest attack or pruning neglect. Such trees can be rejuvenated by regrafting, which is also a good method of replacing useless varieties with modern ones. The apple is taken as the type for illustrating this method.

Heading back the tree.—In December, shorten each main branch to within 15 in. of the trunk. Treat the cut surface with white lead paint to prevent the entrance of disease spores. Immediately before regrafting in late March or early April, shorten each cut back branch a further 3 in., to ensure working the grafts into perfectly fresh wood. The grafts themselves should be retarded a little, as advised in connection with the grafting of young stocks, Figs. 110, 111 and 112.



FIGS. 110, 111 AND 112. GRAFTING

The top diagram shows an old apple tree headed back for regrafting.
The next picture shows how to prepare a branch for regrafting.
The bottom picture shows grafts fitted into the wedge-like incisions.

How to regraft.—In most branches of old trees it is possible to work three grafts, which should be placed equidistant. With a mallet and a sharp knife or small axe, cut out at the edge of the branch wedge-shaped spaces 2 in. deep. After making 2 in. long tapering cuts at the base of the grafts, work one into each incision, and cover the cut part with grafting wax. Very soon the young tree will be formed on the stump of the old one.

Porcupine regrafting.—This is a comparatively new method which reduces the waiting time between regrafting and fruit-bearing. The branches of the old tree are not cut hard back, but the twigs merely are removed. Then into the framework of the tree are worked into wedge-shaped pieces a large number of grafts. When the process is finished the grafts look very much like the spines of a porcupine arising from the branches, hence the name. Though the method is still in its infancy in this country, the reports concerning it are favourable, Fig. 113.

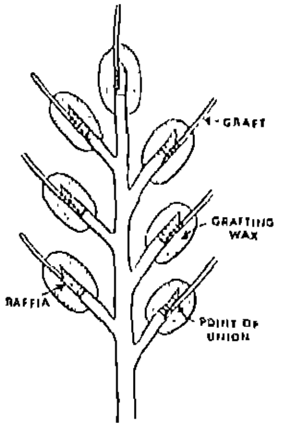


FIG. 113.
PORCUPINE GRAFTING

Root grafting.—A limited number of plants such as tree paeonies, hollyhocks, and clematises, are propagated by root grafting, the reasons being that when they are increased by any of the methods described above, there is danger of canker attacking the point of union between the graft and the stock. Any variety of the garden clematis may be taken as the type. Secure as the stock a specimen of our native Traveller's Joy, *Clematis vitalba.* Cut off the stems where they arise on the roots. In one of the latter make a wedge-shaped incision, working into it a 6 in. long clematis shoot in full leaf. Cover carefully with soil, and water as needed. Late April is an excellent period for this operation. No binding of any kind should be used, and though nurserymen usually graft their clematises in flowerpots in a cold frame, the process is quite successful out of doors.

Root division.—This method of propagation is practised with perennial vegetables such as globe artichokes, rhubarb, mint, sage, thyme, and balm, and perennial flowering plants like Michaelmas daisies, phloxes, heleniums, sunflowers, geums, campanulas, etc. The advantages are three-fold. Division is quicker than seed raising. It ensures trueness to type, and rejuvenates stock that otherwise would deteriorate to the point of exhaustion.

The best time to divide.—Undoubtedly this is when the subject concerned is dormant, namely, between the beginning of November and the end of March. There is much to be said in favour of November, because the soil, though cooling, is still warm enough to ensure rapid re-establishment.

How to divide.—Lift the plant carefully with a four-tined fork. Shake the soil from its roots. Pull it into two sections of equal size if there is no resistance as in the case of a Michaelmas daisy. Cut it with a sharp knife if there is, as in that of the globe artichoke. Replant as quickly as possible, covering the crowns or root tops with an inch of finely pulverised soil.

USEFUL HINTS

Bud a standard rose.—An opportunity should be taken to bud a standard rose at the top of a 3 ft. tall briar dug from the hedges, or a rugosa stock obtained from a nursery. The method is exactly the same, but instead of working one bud into the stock, three are worked at equal distances round it.

Moist soil.—It is better to bud when the soil is moist, because the sap flow is then at its maximum. If showery weather is not opportune, water the stocks thoroughly the day before budding.

Too tight ligatures.—While the raffia ligature used to secure the bud must be reasonably tight, it is possible to get it so tight as to cause constriction of the stem. Make frequent examinations, and if it is observed that there is a stem bulge above or below the ligature, release the latter.

Incompatibility in grafting.—To impress on the minds of the children that only closely related botanical species can be grafted, try working a graft of sycamore on to a rose or a Paradise apple stock. The graft will very soon wither.

Cracking of grafting wax.—Sometimes, especially if very dry weather follows grafting, the wax plug will crack. If it does, it must be removed promptly, and another plug fitted on, otherwise air will reach the cut parts, dry up the cambium, and ruin all prospects of union.

Dividing herbaceous plants.—It very often happens that there are far more divisions than can be accommodated in the garden. When this is so, replant only the outer portions of the old specimens. They are the youngest, and therefore the most vigorous.

Planting holes.—When resetting divided plants, make the holes wide enough to receive the spread-out roots comfortably. When the roots are squeezed into a too small hole, they are unable to form the new fibres on which re-establishment depends.

CLASSROOM WORK

Experimental budding.—Secure wild rose shoots and buds, or even garden rose shoots and buds, and let the children try their hand on this material before attempting to work buds in the garden. Every point connected with the formation of the T-shaped incision and the handling of the buds can then be explained.

Examine rose bud.—Bring a dormant rose leaf bud into the classroom, taken with a little pith behind it. Gather the children round, remove the pith, then tease out the bud, and show them the empty shell of skin. Make the necessary deductions when so doing.

The stock after budding.—The top of the stock is not cut back immediately after budding, because it encourages a vigorous flow of sap past the bud. In the absence of this, the probabilities of union are very remote.

Seedling apples.—The apple has a long and involved parentage. When seed is sown, the seedlings almost invariably revert to an old and inferior type. Now and again a seedling represents a great leap forward, but the issue is too uncertain to make seed sowing an accepted method of apple propagation, hence grafting.

Experimental grafting.—Secure forest tree twigs of varying girth. Demonstrate the different methods of grafting. Also show that it is impossible to graft a twig of small diameter on to a stock of large diameter.

Grafting wax.—Make grafting wax from the following formula:—7 parts Burgundy pitch, 7 parts black pitch, 3 parts yellow wax, 3 parts tallow. The parts are by weight. Boil in an old saucepan, and stir well. Before use, warm the wax slightly.

Purity of stocks.—The selection of stocks for roses and fruit trees has been brought to a fine art. It is most unwise to take risks in this connection. Young stocks of the appropriate kinds should be purchased from a reliable source and grown on in the school garden. Unless appropriate stocks are used, the best variety of rose or fruit may be a complete failure.

The exclusion of air from buds and grafts.—When budding or grafting, extremely delicate tissues are exposed. Air must be excluded from them, or there is not the least possibility of successful union. This important point must not be left to explanation or imagination. It should be demonstrated. Plant two rose stocks and two apple stocks separately in 6 in. pots. Bud the former and graft the latter. Completely enclose the budding point of one rose with moist raffia, and the grafting point of one apple with grafting wax. When applying raffia to the other rose, and wax to the other apple, leave an opening wide enough for air to enter. Watch the result. Where complete protection is given, union will be successful. Where it is not, the bud will wither, and the graft dry up.

The development of suckers.—Explain that though all top growth is removed before grafting, and some time after budding, the stock does not necessarily remain inactive. It may, and often does, develop shoots from the roots, or below the budding or grafting point. These are known as suckers. They are robber growths which kill the variety that was budded or grafted. Bring into the classroom a rose tree or a small fruit developing suckers. Point out clearly that these growths are not of the variety, and that they must be removed at their point of origin. Let the children draw the suckers and the root from which they arise, to press home the explanation.

The bleeding of divided herbaceous plants.—Some herbaceous plants, such as companulas, oriental and Iceland poppies, gypsophilas, and statice, bleed profusely on being divided. Arrest the flow of sap by rubbing the cut parts with freshly slaked lime, or the plants concerned may be gravely weakened.

IX. INSECT PESTS

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COSMEAS

The structure of an insect.—Insect pests are responsible for an enormous amount of damage in the garden. It is essential to know something of their life history, in order to understand methods of control. The body of an insect is divisible into three parts—head, thorax, and abdomen. A perfect insect has six legs. The two eyes are compound, each eye being made up of the union of a large number of hexagonal facets or simple eyes. The mouth parts are constructed for biting or sucking. Respiration is conducted by means of a network of tubes, the entrances to which, known as spiracles, are found in the sides of the body.

The life cycle.—The full life cycle consists of four stages—egg, larva or caterpillar, chrysalis or pupa, and perfect insect or imago. This is known as complete metamorphosis. Some insects, notably aphides or green flies, do not pass through all the stages. Perfect insects may be hatched from eggs, or may be born alive. The metamorphosis here is said to be incomplete.

Classification.—For horticultural purposes insects may be divided into three classes—

biters, suckers, and internal feeders. The terms suggest the reasons for this classification. Biting insects inflict damage in the larval stage. Their larvae consume leaves or portions of leaves. The cabbage white butterfly, which mutilates vegetables in the cabbage family, is an example.

Sucking insects are provided with a tongue or proboscis, with which they pierce plant tissues, extracting sap from them. Green flies and thrips are examples.

Internal feeders burrow their way into plant tissues and devour them. The onion fly is an example.

Biting insects.—It is proposed to give the full life history of the **Large White Cabbage Butterfly,** *Pieris brassicae*, to show how the whole question of insect pests should be tackled, Fig. 114. When the details of the life history are known, the student realises at which point he should deliver his attack.

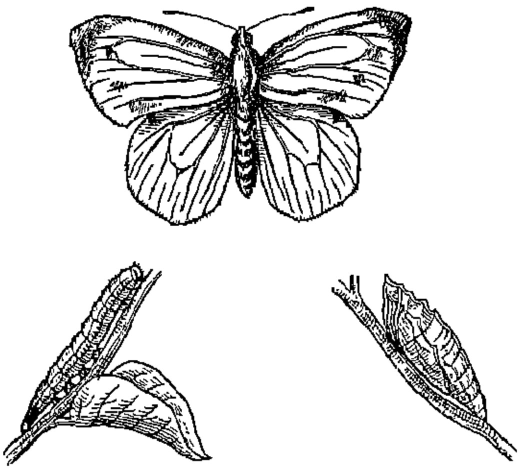

Fig. 114. The Large White Cabbage Butterfly with Larva and Pupa

Description of butterfly.—Wing stretch 2¾ in., wings white, except the base, the apex, a mark on the margin of the fore and hind wings, which are black.

Description of larva.—Greenish yellow, sprinkled with black spots, with a yellow line running down the back, and one on each side above the feet. The head is black. There are sixteen "feet." Length of larva 1¼ in.

Description of pupa.—Angular, marked by yellow and black spots. Length ¾ in.

Life history.—In spring the female lays clusters of eggs on the under side of the leaves of members of the cabbage family, and other plants such as wallflowers and nasturtiums. In a fortnight the larvae appear, and at once begin to feed on the leaves, riddling them into holes. The feeding period is approximately one month, when the larvae retire to a wall or fence to pupate.

Second brood.—Pupation lasts until mid-July, when the second brood of perfect insects appears, and the life history is repeated. Pupation again takes place in late September, the pupae attaching themselves to walls, fences, and trees for the winter.

Control measures.—Destroy eggs, pupae, and perfect insects as far as possible. For the latter purpose, a small net is very useful. Hand picking the larvae may be practised when the infestation is not serious, and the number of plants few. Complete immunity can be secured by spraying host plants fortnightly from mid-May until early September with a solution prepared by dissolving 1 oz. of table salt in a gallon of water. The salt film thus deposited on the leaves deters egg-laying, and should the salt wash off between the sprayings, destroys the larvae when the next application is given.

Small white cabbage butterfly and green-veined white butterfly.—The life history and control measures are similar to the above.

The cabbage moth.—The larvae feed amongst the leaves from June to September. Spraying fortnightly with lime water (2 ozs. of lime in a gallon of water) prevents attack. Hand picking and destruction of moths and pupae are helpful.

Turnip sawfly.—This insect slits turnip and swede leaves and lays eggs in them. The small black larvae feeding in great numbers devour

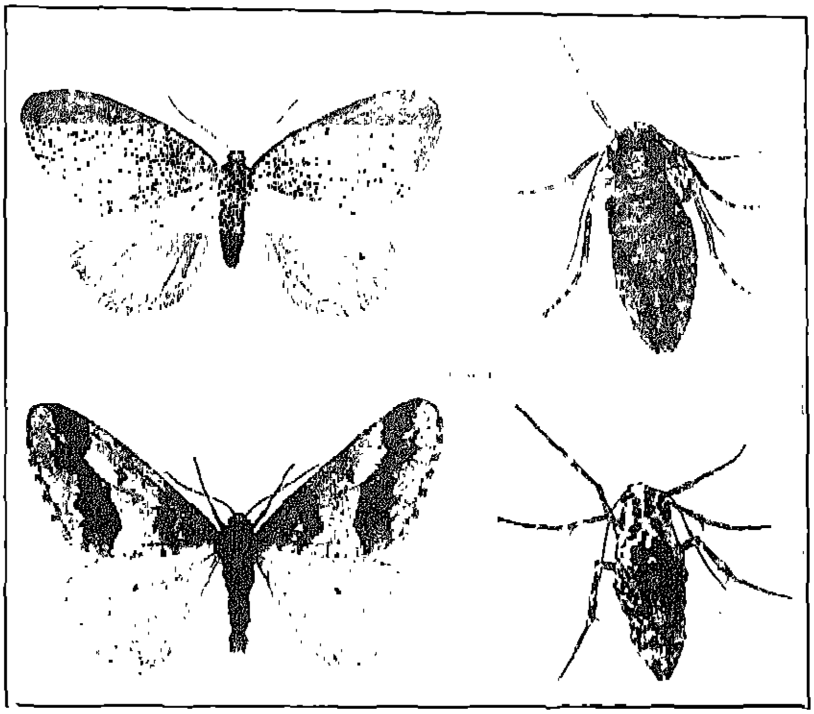

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FIG. 115. WINTER MOTHS

A. Winter Moth, male (magnified).
B. Winter Moth, female (magnified).
C. Mottled Umber Moth, male (magnified).
D. Mottled Umber Moth, female (magnified).

all but the veins. Is controlled by lightly brushing infested plants, when the larvae fall to the ground and perish. Dress infested crop with nitrate of soda at 1 oz. per yard run of drill, to accelerate growth, and help the plants quickly through the vulnerable phase.

Winter moth.—A serious pest of the apple (Fig. 115), it lays eggs in the branches from October to March. The larvae feed on young fruit, leaves, and even blossoms, twisting them together in a hopeless mess. Can be controlled by applying grease-bands to the trees in late September, Fig. 116. The egg-laying females are wingless, consequently must crawl up the trunks to lay eggs. In doing so they are caught in the grease, and perish. In the absence of grease-banding a larval attack can be destroyed by spraying promptly with lead arsenate wash. There are several species of winter moths having a similar life history, and to which similar control measures apply. Occasionally pears, plums, cherries, and small fruit are attacked, but the apple is the worst sufferer.

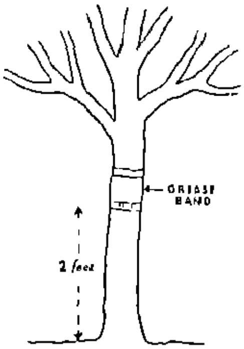

FIG. 116. GREASE-BANDED APPLE TREE

Small ermine moth.—Attacks many kinds of fruit trees and flowers, Fig. 117. Numerous eggs are laid on the leaves in May. The larvae, on hatching out, spin a web, and feed in colonies beneath it. Hand

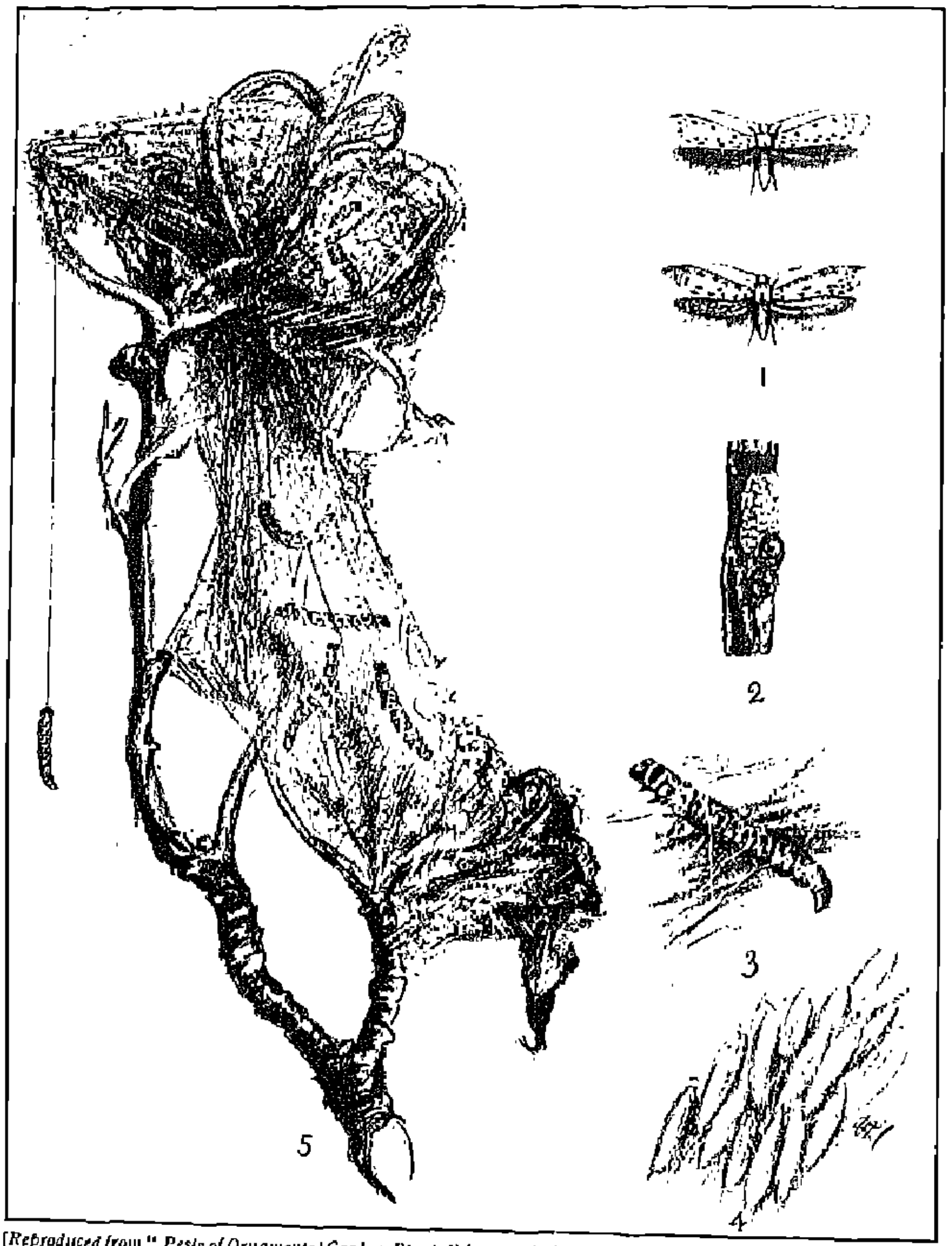

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FIG. 117. SMALL ERMINE MOTH

1. Small Ermine Moth.
2. Egg Mass.
3. Caterpillar.
4. Cocoons.
5. Apple shoot with Web.

picking or spraying with paraffin emulsion, is remedial.

Green capsid bug.—This pest attacks both herbaceous plants and fruit trees, Fig. 118. It thrives on cultivated trees, shrubs, herbaceous plants of many kinds, annuals, and weeds of all kinds. The adult insect is bright green in colour and is covered with dusky hairs. The eggs are laid in the shoots of fruit trees and on rose trees. They hatch in spring and the larvae feed on the leaves of such plants as the apple, currant, gooseberry, etc. Often when they are half grown they crawl away to live on various herbaceous plants. When the adult bug is formed it flies away to other plants, particularly succulent herbaceous plants and weeds, and there it lays its eggs. This second generation hatches and feeds on the plants on which it was laid, returning to woody plants when full grown and laying eggs which are inserted in the shoots.

There are a number of special washes on the market designed for the killing of the eggs of the capsid bug, and fairly satisfactory results will be obtained if the fruit trees are sprayed during the dormant season in order to destroy the eggs in the shoots. All the shoots, branches and stems must be forcibly sprayed and covered with the wash. It is possible, also, to destroy the young bugs on fruit trees by using a nicotine soap wash and nicotine or derris dusts. The wash should be applied fairly soon after the leaves show signs of the presence of the pest. The larvae of the second generation on the herbaceous plants may be killed by means of a nicotine or derris wash or dust. The insects can then be shaken off the plants into a basin placed beneath the afflicted shoots. Weeds, which often harbour many of these bugs, should be destroyed during July when the insects are feeding on them. All the weeds on fruit plantations or in shrubberies should be dug into the ground; those in flower borders should be pulled out and destroyed.

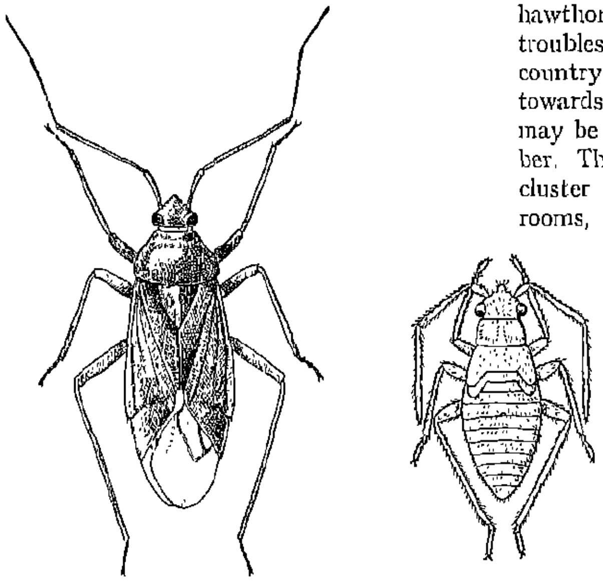

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FIG. 118. GREEN CAPSID BUG

Adult (much magnified) Larva (much magnified).

The lackey moth.—This pest attacks trees of all kinds, including forest trees, fruit trees, ornamental shrubs and roses and hawthorns, Fig. 119. It is particularly troublesome in the southern part of the country. The moths can be seen flying about towards the end of July, and sometimes they may be found as late in the year as September. They fly at night, and the male moths cluster round street lamps or enter lighted rooms, being attracted by the light. The females lay bands of eggs round the shoots of plants, each band consisting of about one hundred to two hundred eggs. These bands are quite conspicuous. The eggs hatch towards the end of April and small, hairy larvae, dark in colour appear. These soon become bright coloured and live on the shoots where they form "nests" of web. They are extremely destructive, often completely defoliating the plant, leaving only bare shoots covered by a huge silken web.

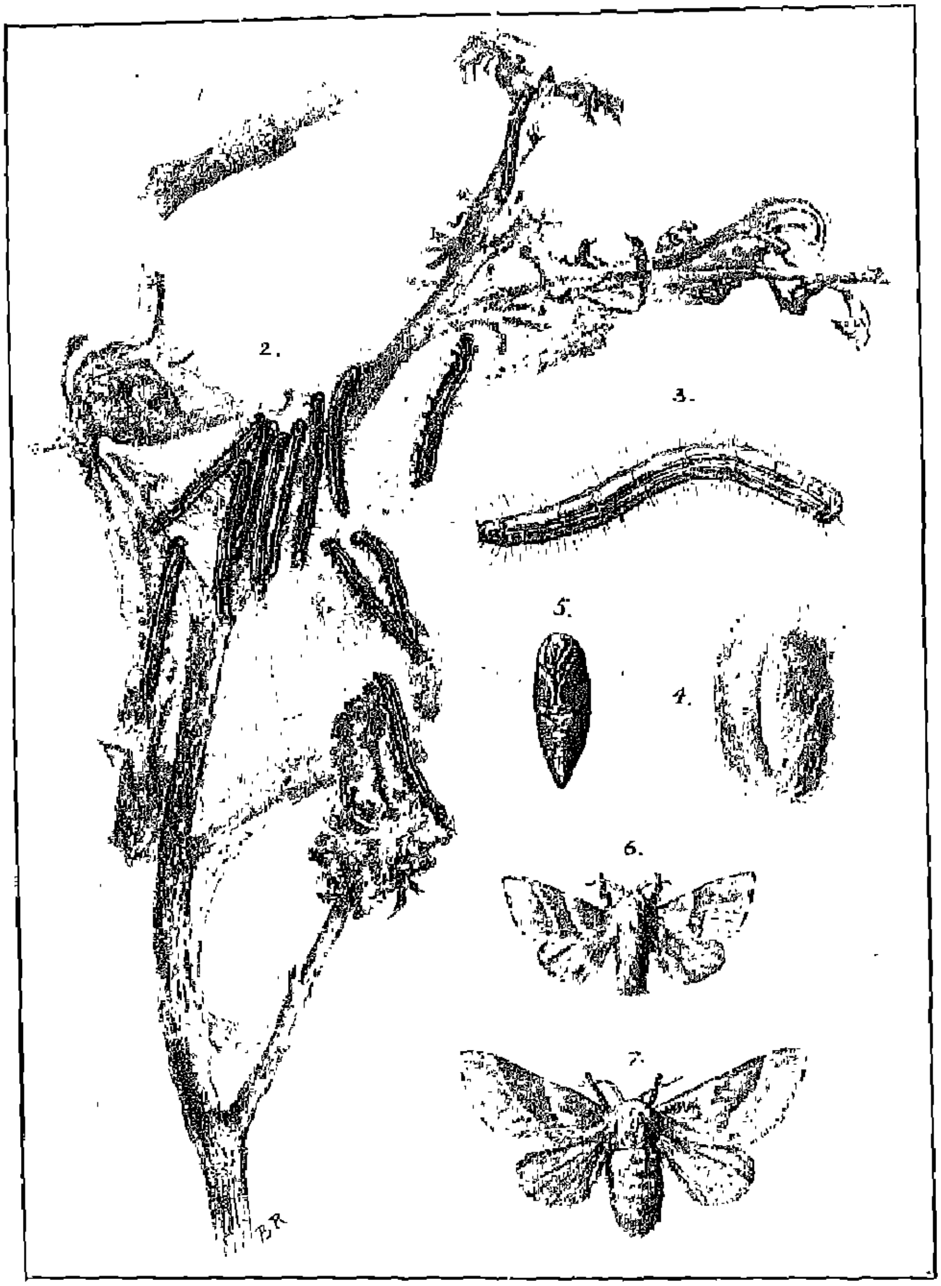

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FIG. 119. LACKEY MOTH

1. Eggs on twig.
2. Web on apple branch, showing caterpillars and cast skins.
3. Full-grown caterpillar.
4. Cocoon.
5. Chrysalis.
6. Male Lackey Moth.
7. Female Lackey Moth.

Pupation occurs during June on the trunk of a tree, between leaves and shoots, on fences or among grass or any other foliage.

The pest can be controlled by pruning off all shoots bearing the egg bands and destroying them. The "nests" of larvae may be cut out and also destroyed, care being taken that none of the caterpillars escapes. The larvae are easily killed by spraying the leaves slightly with an arsenical wash.

Leaf-cutting bee.—This insect cuts portions out of the leaves of many plants, especially roses, for nest making. Light dusting with tobacco powder is a safeguard. There is no need for this treatment unless it is evident that the insect is present.

Pea weevil.—This insect attacks culinary and sweet peas, eating semicircular portions out of the leaf margins. It is a night feeder, hiding in the soil during the day. An excellent remedy is light dusting with freshly-slaked lime, while if the soil near infested plants is pressed firmly, the insects will perish in it.

Sucking insects.—The broad bean aphis.—This also attacks the runner and French beans. It passes winter in the egg stage on the spindle tree, *Euonymus europaeus*; feeds on this species from early April until the end of June, when infestation occurs in the growing points of broad beans. Multiplication is very rapid indeed; immediately an attack is observed, nip out and burn the growing points if the broad beans have finished blooming. If they have not, destroy the pest by spraying with soft soap solution (4 oz. in a gallon of water). Spray with clear water next day to remove the soap sediment. Spraying with this solution is effective when, after leaving broad beans, the pest passes to runner and French varieties, Fig. 120.

Green aphides or green flies.—There are several hundreds of these feeding, according to the species, on practically every plant in the garden. On subjects of succulent growth such as green vegetables, roses, and herbaceous plants, spraying with soft soap solution is effective. Nicotine insecticide may be used on flowers, but for obvious reasons, not on vegetables. As a safeguard against green fly attack, all kinds of fruit trees should, between early December and mid-January, be sprayed with a tar-oil wash to destroy the eggs, which at this period have been deposited in the branches. On account of the concentration of tar-oil washes, they must be used when the sap is dormant. When fruit trees are attacked by green flies during the growing season, spraying with nicotine insecticide is the remedy.

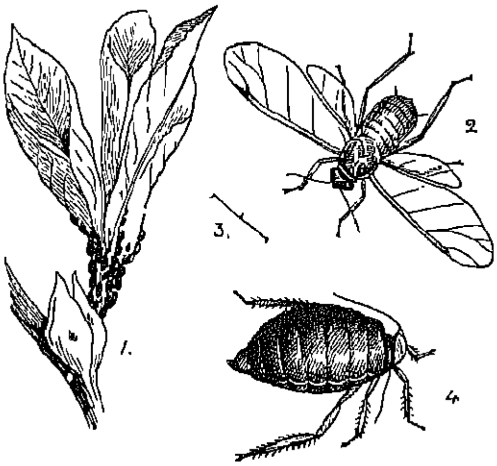

FIG. 120. THE BEAN APHIS OR BLACK FLY

1. Infested bean plant.
2. Male enlarged.
3. Natural size of male from tip to tip of wings.
4. Female (wingless) enlarged.

Thrips.—There are many species, and many host plants, sweet peas, roses, and onions are serious sufferers. These insects are about $\frac{1}{12}$ in. long, and black or yellow in colour. They drain the sap to such an extent that the leaves become quite pallid. Vigorous spraying with clear water or derris solution will exterminate them.

Leaf-rolling sawfly.—A pest peculiar to the rose, Fig. 121. The larvae curl the leaves and feed inside them. Hand picking is the

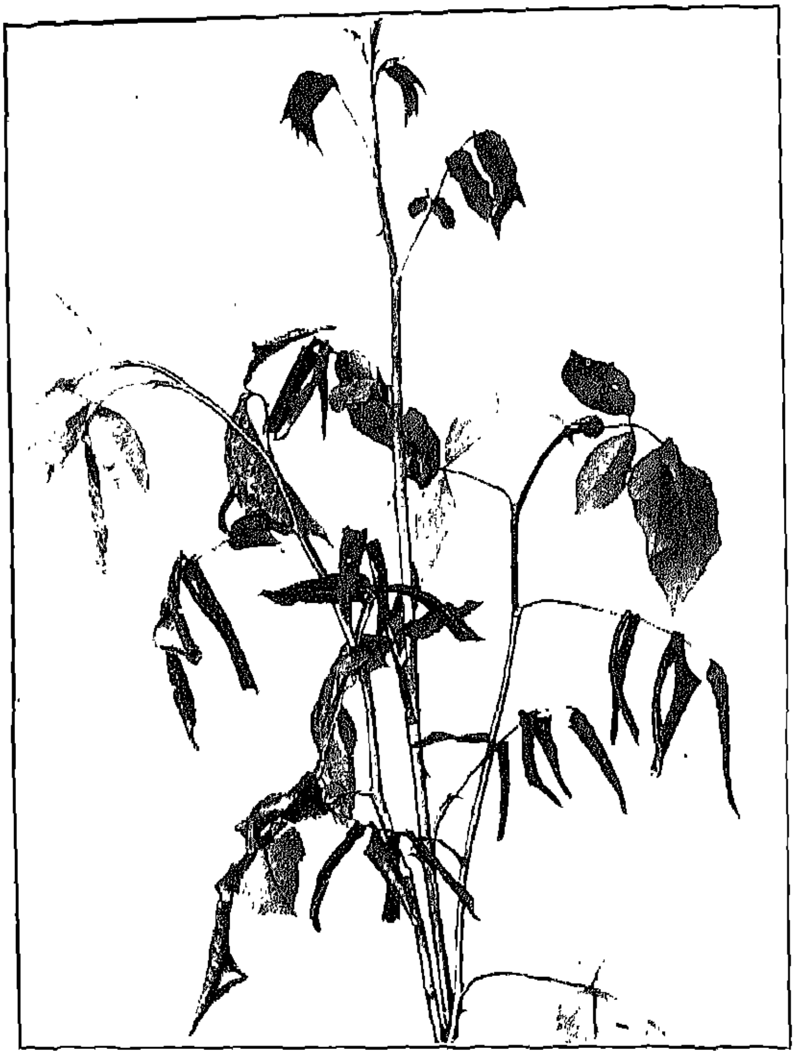

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FIG. 121. EFFECT OF ROSE LEAF-ROLLING SAWFLY

only remedy, as no spray can reach the pest in its protected position.

Froth fly.—Infests a wide variety of plants, feeding beneath a blob of spittle excreted by itself. Sometimes called the frog-hopper. Blowing the spittle, and spraying with nicotine insecticide are remedial.

Cabbage aphis.—A blue-green, mealy, wingless insect that feeds in colonies on the under surface of the leaves of members of the cabbage family. Effective control measures are, to dust with derris powder or spray with soft soap solution.

White fly.—In warm summers causes great destruction among celery, beetroot, members of the cabbage family, roses and sweet peas. A sure remedy is to spray three times, at intervals of three days, with derris wash.

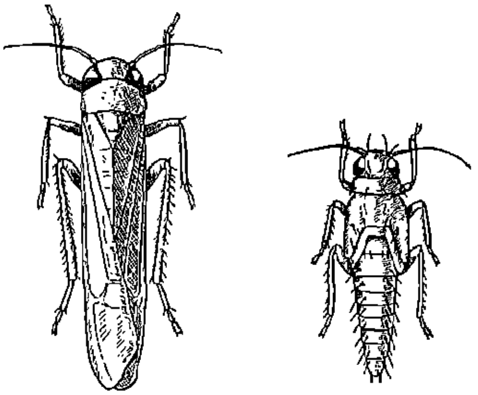

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Fig. 122. Rose Leaf Hopper

Adult (much magnified). Larva (much magnified).

Rose leaf hopper.—This insect attacks roses during the months of May, June and July, Fig. 122. Pale, mottled areas appear on the rose leaves and, when the weather is dry, the sucking of the many larvae on the undersides of the leaves causes them to fall prematurely. The adults are pale yellow in colour and when the rose bush is disturbed they take flying leaps into the air. They lay their eggs underneath the skin of the leaf any number up to four being placed close together. The larvae, which are pale yellow in colour, suck the juices of the leaf causing a series of patches to appear. During midsummer the insect may be found on the leaves in all stages of its development, including the dry, greyish cast-skins which can easily be mistaken for the insects themselves. In August and September a second brood appears. During the winter the pest lives in the larval stage and also in the adult stage although to a lesser degree. Both bush roses and climbing roses are attacked.

As soon as the larvae are observed on the foliage in spring, the plants should be forcibly sprayed with a nicotine soap wash. It is most important to spray on the undersides of the leaves where the insect lives in all its stages. After the foliage has been sprayed, the ground beneath the infested bushes should also be sprayed in order to kill the insects which fall to the ground during the spraying of the leaves.

Internal feeders.—The onion fly.—This ¼ in. long, two-winged fly attacks the onion extensively, and on rare occasions the leek and the shallot. Lays eggs in early summer on the neck of onion bulbs. The larvae hatch in seven days. They bore into the bulbs, form galleries, and before pupating in a fortnight, reduce the bulbs to pulp. Pupation may take place in the bulb or in the soil. It lasts seven days, when egg-laying imagos appear. There may be three generations in one season. No remedy is known, but an attack can be prevented by spraying with paraffin emulsion fortnightly from the end of May to early September, Fig. 123.

The carrot fly.—A pest peculiar to the carrot, Fig. 124. Feeds in the roots. No

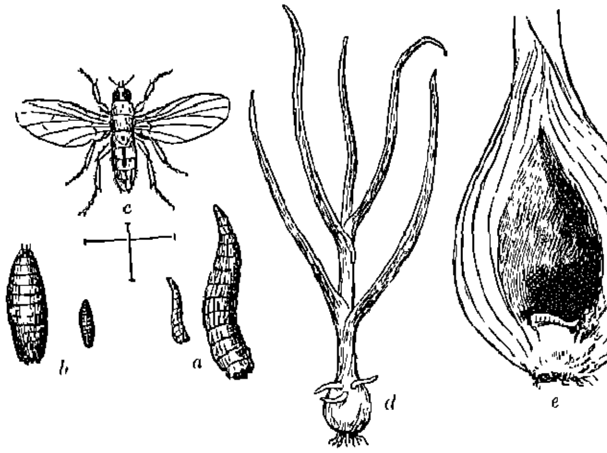


Fig. 123. The Onion Fly

a. Maggot enlarged and natural size.
b. Pupa enlarged and natural size.
c. Fly enlarged: the crossed lines show the natural size.
d. Young plant attacked by maggots.
e. Maggot eating a bulb.

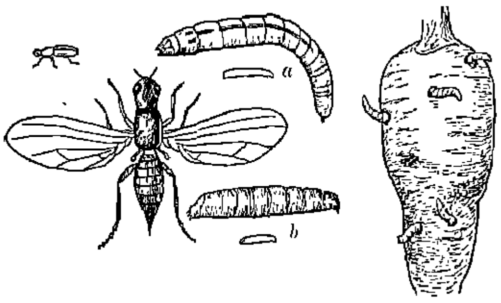


FIG. 124. THE CARROT FLY

a. Maggot enlarged and natural size.
b. Pupa enlarged and natural size.
c. Fly enlarged and natural size.
d. Carrot root infested by maggots.

remedy is known, but an outbreak can be prevented by spraying with carbolic sheep dip solution (½ oz. in a gallon of water) at ten day intervals from the end of May until early September.

The cabbage root fly.—The larvae of this fly feed in the main roots, and at the base of the main stem of members of the cabbage family, Fig. 125. Prevention is better than cure. It is effected by surrounding each main stem at planting time with a tarred felt disc, which interposes an obstacle to egg-laying. Grubs feeding in the plants can be destroyed by watering each with commercial corrosive sublimate solution (1 oz. in ten gallons of water). One pint per plant is a suitable dose.

The wireworm.—This is the yellow hard-cased larva of the *Click Beetle*, Fig. 126. Feeds longer than any other British pest—three to five years. Attacks potatoes, asparagus, sweet peas, tomatoes, vegetable marrows, carnations, and in cases of heavy infestation, any kind of succulent root. Is easily destroyed by stirring in a 2 oz. per square yard dressing of equal parts whizzed napthalene and freshly slaked lime. Avoid contact with the leaves when making the application. Keep down tussocks of grass on the paths and in odd corners. These are favourite egg-laying stations.

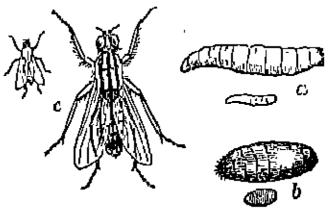


FIG. 125. CABBAGE ROOT FLY

a. Legless maggot enlarged and natural size.
b. Pupa enlarged and natural size.
c. Fly enlarged and natural size.

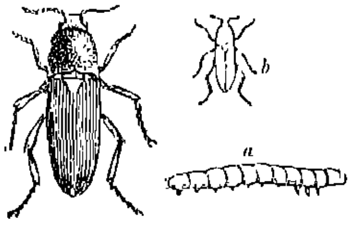


FIG. 126. THE CLICK BEETLE

a. Wireworm.
b. Click beetle, natural size.
c. Click beetle, enlarged.

Gall weevil.—This insect causes small round swellings on the roots of turnips and members of the cabbage family, Fig. 127. The larva feeds inside the swelling. Cut off the swellings when planting greens, and burn them. Dress infested ground with freshly slaked lime (6 oz. per square yard) as soon as the crop is lifted. No useful action can be taken while it is in the ground.

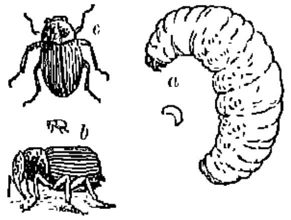


FIG. 127. CABBAGE GALL WEEVIL

a. Grub enlarged and natural size.
b. Side view of beetle enlarged and natural size.
c. Back view of beetle enlarged.

Pea moth.—This insect pierces the pods with its egg-laying apparatus, depositing eggs inside. The larvae attack the seeds. Dusting with tobacco powder is a safeguard.

Codlin moth.—An apple pest. The eggs are laid on the fruit. The larvae bore a passage to the core, where they eat the seeds.

Grease-banding, as suggested for winter moth, traps the larvae when they leave the fruit to pupate. All harbour in the shape of rubbish and dead grass should be cleared away from the vicinity of the trees. Spraying with lead arsenate wash as soon as the petals fall prevents egg-laying.

Apple sawfly.—The larvae feed inside the fruit in exactly the same way as those of the codlin moth. Spraying with lead arsenate wash immediately after petal fall is an effective safeguard.

Leaf-mining maggots.—There are many species, attacking chrysanthemums, marguerites, roses, carnations, dahlias, celery, beetroot, and many other subjects, Fig. 128. The larvae feed between the two skins of the leaves, forming serpentine passages. Light dusting with weathered soot at fortnightly intervals from early May until the end of August is preventive. Spraying with nicotine solution (1 oz. in 10 gallons of water) kills the larvae. Hand picking and destruction of the infested leaves is useful in light attacks.

Of general interest.—It should be remembered that while immunity from insect pest attack is not attainable, healthy, well-cultivated plants are more likely to escape. If the ground is well manured, regularly hoed, and thinning, staking, and in-season feeding receive attention at the appropriate time, the plants concerned acquire resistance power.

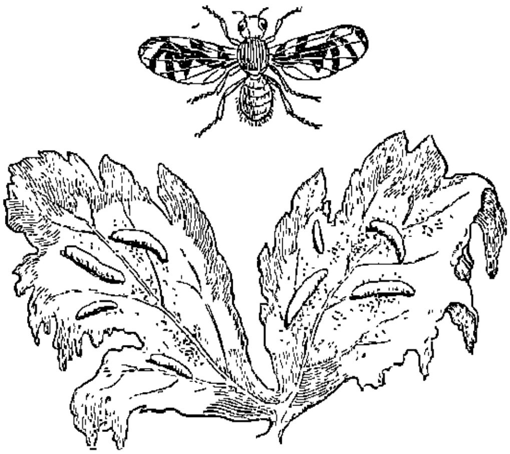


FIG. 128. THE CELERY FLY

The fly is only about ⅛ in. long: the upper skin of the leaf has been removed to show the legless maggots at work underneath.

USEFUL HINTS

Insect attacks.—Though healthy crops are often attacked by insect pests, it is recognised that those in a run-down condition are more susceptible. Hence the need for sound, generous methods of culture, and also the value of combining preventive or remedial measures with the application of a quick-acting stimulant such as nitrate of soda.

Cabbage white butterfly parasite.—The caterpillars of the cabbage white butterfly are parasitised by the larvae of the ichneumon fly, *Microgaster glomerata*, which lays its eggs beneath the skin. The larvae feed on the flesh of the caterpillar, afterwards pupating on the leaves or on the skin, Fig. 129.

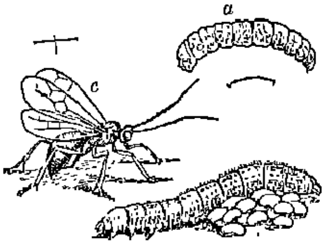
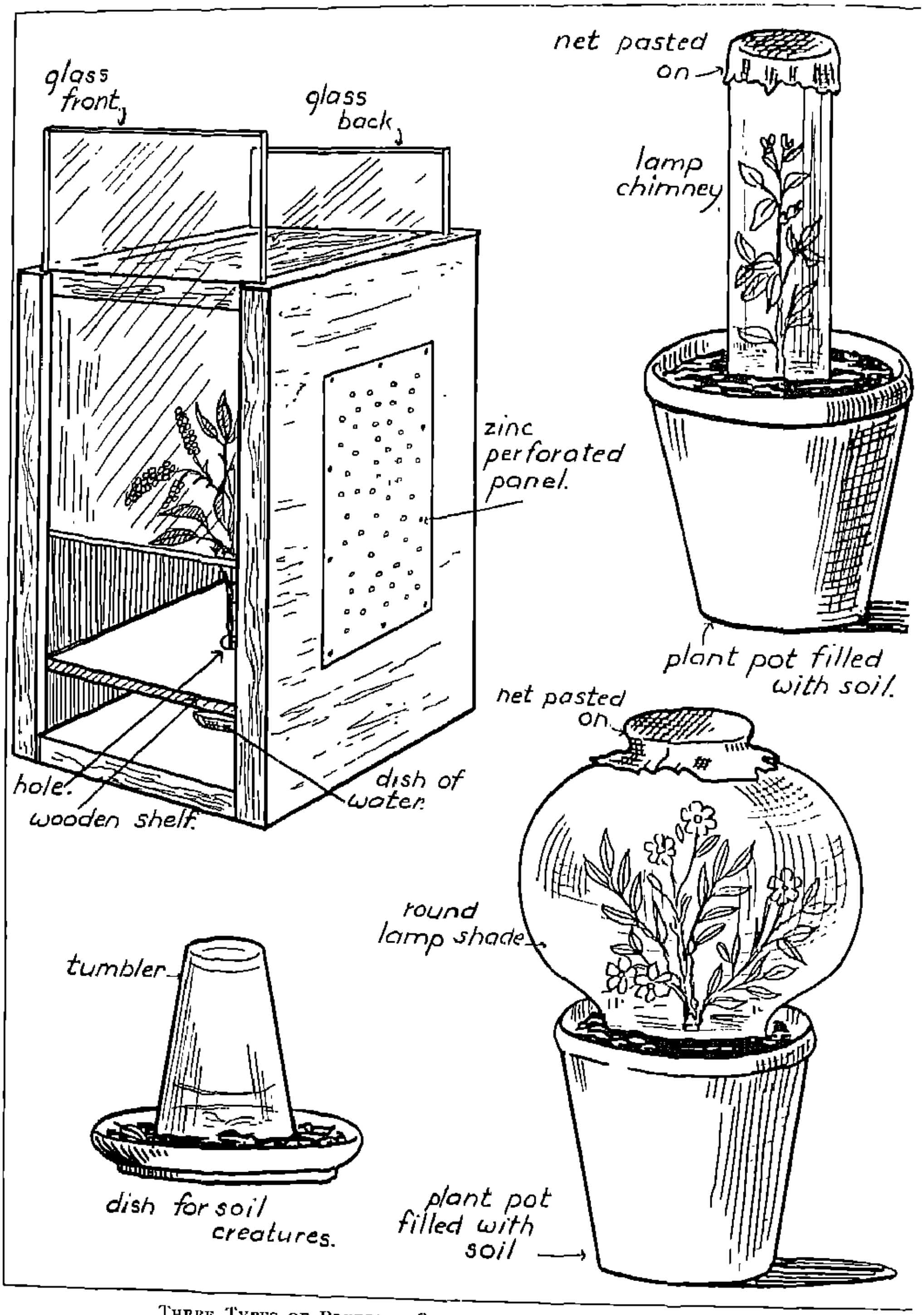


FIG. 129. THE ICHNEUMON OR HUNTER-FLY

a. Maggot enlarged; the line shows the real size.
b. Dead caterpillar with cocoons of the fly lying outside the body.
c. Fly enlarged; the crossed lines show the real size.

Conditions for spraying.—Choose calm, dull, dry weather. Wind diverts the spray. Sunshine evaporates it too quickly, while rain dilutes and renders it futile.

Aphides attack.—The large family of aphides, or green and black flies, invariably open the attack in the growing point of the



Three Types of Breeding Cages for Moths and Butterflies
"Home" for Soil Creatures

host plant, where the tissues are succulent and easily penetrated. An effort should be made to exterminate the pests before they spread from the growing point. This course saves time, labour, and material, and reduces damage to the minimum.

Derris insecticides.—Though derris insecticides have been used in a small way for a long period, it is only in recent years that their value has become fully appreciated. They are very lethal, and being non-poisonous, are safe to use.

Preventive sprays.—The value of preventive sprays lies in faithful application. If the interval between sprayings is a fortnight, this period must not be over-run, or the preventive influence will be weakened, and the pest break through.

Rotation cropping.—Rotation cropping is a firm ally in keeping down root pests such as carrot fly, onion fly, and cabbage root fly, which pupate in the soil in which the attacked crop was grown. By changing the site, the crop concerned is removed from its enemy.

CLASSROOM WORK

Life cycle of an insect.—Collect the eggs of some insect, such as the cabbage white butterfly. Place them under a slightly tilted tumbler in a window in the classroom. Provide fresh leafage as food. Watch carefully the development through the various stages, and make appropriate diagrams.

Cardboard discs.—Stiff cardboard discs 2 in. square, and slit from the centre of one side to the centre of the disc, where a small hole should be made for the reception of the stem, are, as preventives of cabbage root fly attack, quite as effective as the tarred felt discs. A supply of cardboard discs might be made in the classroom.

Broad bean aphis.—Bring into the classroom two broad bean shoots slightly infested by black fly. Accommodate them in separate tumblers filled with water, stand one tumbler in a warm window, the other in a cool place. Note that warmth accelerates the rate of increase, proving that in warm weather this and other pests multiply more rapidly.

Grease-bands.—Make grease-bands out of stiff butter paper, each band to be 5 in. wide and 18 in. long. Butter paper is best, because the grease does not soak in.

Thrips attack.—Bring into the classroom leaves infested by thrips. Note that the attack is on the under surface, and that most of the thrips are feeding in the creases of the leaves, showing how necessary it is to spray vigorously when dealing with this pest. Sweet pea and French bean leaves are admirable material for the illustration.

Collect weeds.—Collect an example of every kind of weed in the school garden, and make a list of the number of insect pests found on them. There may be root fly on charlock, black fly on thistle, red spider on groundsel, and thrips on chickweed. These pests pass from weeds to cultivated crops, a powerful argument for the suppression of weeds.

Humorous poems.—Reginald Arkell has written some very amusing poems connected with gardening. The following will interest the children.

GREEN FLY

Of every single garden pest,
I think I hate the Green Fly best.
My hate for him is stern and strong:
I've hated him both loud and long.
Since first I met him in the spring
I've hated him like anything.

There was one Green Fly, I recall;
I hated him the most of all.
He sat upon my finest rose,
And put a finger to his nose.
Then sneered, and turned away his head
To bite my rose of royal red.

Next day, I noticed, with alarm,
That he had started out to charm
A lady fly, as green in hue
As all the grass that ever grew.
He wooed, he won; she named the night—
And gave my rose another bite.

Ye gods, quoth I, if this goes on,
Before another week has gone,
These two will propagate their kind,
Until, one morning, I shall find
A million Green Fly on my roses,
All with their fingers to their noses.

I made a fire, I stoked it hot
With all the rubbish I had got;
I picked the rose of royal red
Which should have been their bridal bed;
And on the day they twain were mated
They also were incinerated.

Reginald Arkell.

I SAW NINE PESTS

As I sat under a poplar tall,
I saw nine pests come over the wall.

I saw nine pests come wandering by;
A slug, a snail and a carrot fly.

I saw nine pests descending on me;
Wireworm, weevil and radish flea.

I saw nine pests, a depressing sight:
Pear midge, mildew and apple blight.

Nine garden pests came over the wall,
And the woolly aphis was worst of all.

Reginald Arkell.

THE LADY WITH THE LAMP

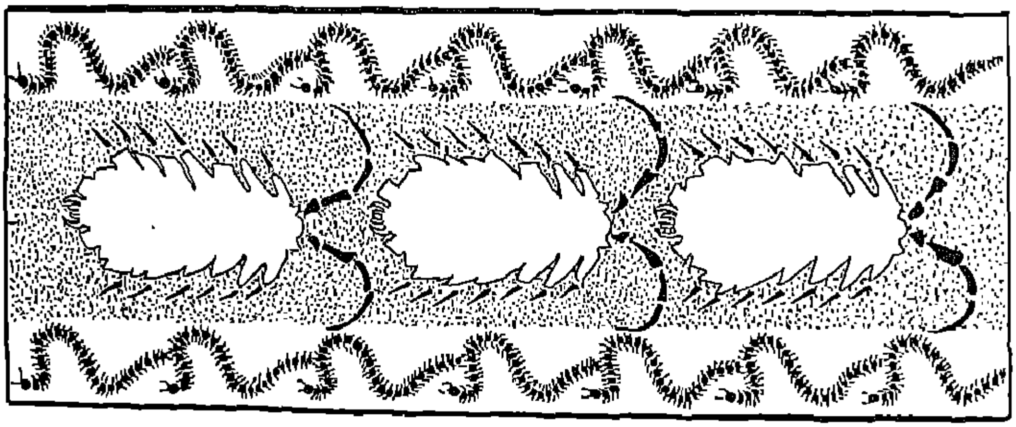
There is a lady, sweet and kind
As any lady you will find.
I've known her nearly all my life;
She is, in fact, my present wife.

In daylight, she is kind to all,
But, as the evening shadows fall,
With jam-pot, salt and sugar-tongs
She starts to right her garden's wrongs.

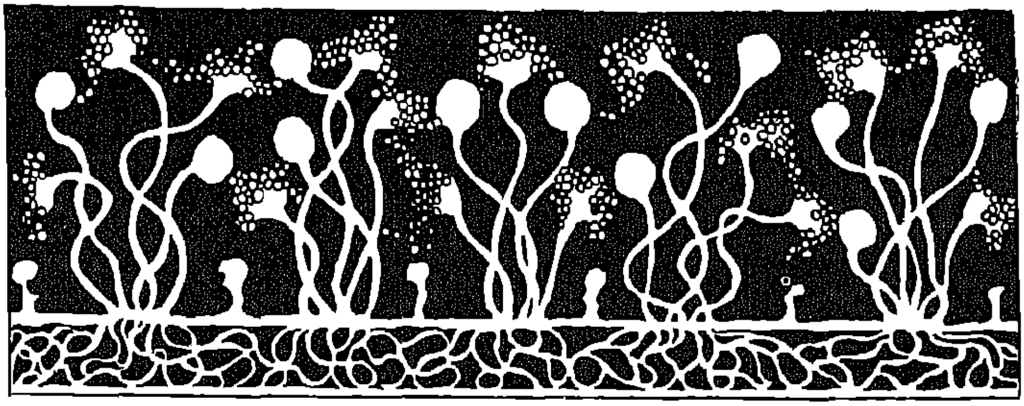
With her electric torch, she prowls,
Scaring the Nightjars and the Owls,
And if she sees a slug or snail
She sugar-tongs him, by the tail.

Beware the pine-tree's withered branch,
Beware the awful Avalanche—
And Slugs, that walk abroad by night,
Beware my wife's electric light.

Reginald Arkell.



X. FUNGOID DISEASES



The life history of a fungus.—Fungi, a very large division of the vegetable kingdom, possess no chlorophyll or green colouring matter, hence are unable to manufacture organic food on their own account. Consequently they must "steal" their food from organisms which have this power. When fungi live upon dead material, they are known as saprophytes. With them the gardener is concerned in a minor degree only. His concern is with the parasites which live upon living green plants. They are responsible for the most serious diseases, and it is incumbent upon every gardener to know something about these diseases, and how they can be controlled.

Pythium de baryanum is taken as the type, because it is responsible for the very common disease of damping off of seedlings, and also because in structure and mode of life it represents fungi as a whole. Infection is caused by resting sporangia or spores alighting on seedlings which are embarrassed by an over damp atmosphere or low temperature. Stimulated by contact with an appropriate host, the spores germinate, forming minute threads called mycelium. The individual threads are known as hyphae. At certain points where the threads cross, conjugation takes place. As a result of it, the fungus develops on branched threads another type of spore termed the zoospore. This provides for rapid multiplication. The spores are shed in great numbers, and alighting on other seedlings, spread infection.

The vegetative part, that is, the mycelium, ramifies within the tissues of the host, secreting a ferment that dissolves the cell walls, and appropriates the contents of the cells. The reproductive part, namely, the spores, are produced externally, resembling a whitish brown mould. Naturally, encompassed by such terrible invaders, the seedlings rapidly collapse. When the food supply of the fungus gives out, resting conidia are produced. They may lodge in the soil, or find their way into the atmosphere. In any event they can remain dormant for long periods until they find another suitable host.

Control measures.—There is no cure, but if seedlings are watered fortnightly with Cheshunt Compound (1 oz. in 2 gallons of water) from the time they appear until they have formed their second normal leaf, they will escape attack. The compound destroys the resting conidia in the act of germinating. Hygienic conditions, such as a porous soil, clean receptacles, and, under glass, the maintenance of a reasonably dry atmosphere, are further safeguards.

To sum up the life history given, and apply it to plant diseases in general:—all fungi appropriate the tissues of their host plants; all spread in or on the organs attacked by means of mycelium, and all produce active and resting spores.

Principal fungoid diseases.—Now it is proposed to give a few of the principal diseases, and the measures that should be taken against them.

Apple and pear scab.—Attacks the leaves in spring, and passes on to the fruit, forming ugly gaping cracks. Passes from the fruit to the wood, on which it winters. Cut out and burn diseased wood. When the flowers are in the green bud stage, spray with lime sulphur solution (1 part in 30 parts of water). Spray with lime sulphur solution (1 part in 60 parts of water) immediately after the flowers fall. The two sprayings are essential.

Brown rot.—Attacks apples, pears, plums, and occasionally cherries. The disease first appears on the leaves, afterwards passing to the fruit, on which it forms greyish olive spore centres in the shape of fairy rings. The spores from the fruit are shed on to the young wood, which ultimately is killed. From this wood the spring spores are produced. Cut off and burn all mummified fruit and dead twigs in winter and, just as the leaves are unfolding, spray with liver of sulphur solution (1 oz. in 3 gallons of water). Regular liming enables fruit trees to resist this disease.

Silver leaf.—Plum, cherry, apple and pear, are susceptible, the two first named more so. The leaves of affected shoots assume a silvery appearance. Ultimately, affected branches die, and bear purplish white, plate-like fructifications. Diseased branches must be cut off and burned, making the cut immediately below the point at which the wood ceases to have a brown stain. Treat the cut surface with white lead paint to prevent further infection.

Mildew.—A widespread disease affecting apples, roses, sweet peas, culinary peas, delphiniums, and many other subjects. Can be destroyed by dusting the affected parts (which are covered with a white or purplish white, downy mould) with a mixture of 2 parts flowers of sulphur and 1 part freshly slaked lime, or by spraying with rose pink permanganate of potash solution.

Die-back disease.—This is likewise of wide incidence, gooseberries and roses being amongst the worst sufferers. Affected branches wilt suddenly, and die. Spraying is futile. Cut off and burn stricken branches, treating the cut surface with white lead paint.

Canker.—This devastates apples, pears, roses, almonds, azaleas, and many similar woody plants. The fungus works internally, ultimately bursting the bark and forming scabs. Where only small unimportant branches are attacked, they should be cut off and burned. Where a larger limb is involved, pare off the scabby part, treating the sound wood underneath with white lead paint.

Wilt disease.—This attacks asters, causing the plants to collapse suddenly and die. There is no remedy, but watering with Cheshunt Compound (1 pint per plant per dose) fortnightly from planting out until the flowers open is an effective safeguard.

Rhizome rot.—This is a disease of flag irises which attacks the rhizome or creeping stem, causing it to decay. Lift affected plants, and after washing the roots under a running tap, steep them and the rhizomes in rose pink permanganate of potash solution for twenty minutes before replanting.

Rust disease.—This is prevalent on many subjects, including roses, border carnations, chrysanthemums, and Canterbury bells. Begins by forming yellow leaf blotches, on which clusters of rusty red spores form. Spray with liver of sulphur solution (1 oz. in 3 gallons of water) as soon as the first symptoms are observed.

Black spot.—The most serious disease to which roses are liable. Infects the leaves, forming inky black blotches on them, and the shoots also, withering them badly. Affected shoots should be cut off and burned, and the bushes sprayed with half strength Bordeaux Mixture.

Sweet pea streak.—The cause of this disease is uncertain, but is thought to be a virus. Forms dark green stripes in the leaves and stems, completely paralysing growth. Affected plants should be lifted and burned, and healthy ones watered weekly for a month with sulphate of potash solution (1 oz. in a gallon of water and one gallon per yard run of row).

Gladiolus smut.—Affects the bulbs, shrivelling up the tissues, and destroying the embryo. As a safeguard against infection, steep the bulbs for an hour before planting in a solution prepared by dissolving 1 oz. of liver of sulphur in 3 gallons of water.

Club root disease.—Peculiar to members of the Natural Order *Cruciferae*. Specially troublesome to turnips, and members of the cabbage family. Effective safeguards are rotation planting, and triennial applications of freshly slaked lime at 6 oz. per square yard. A certain remedy is to water affected plants with commercial corrosive sublimate solution (1 oz. in 10 gallons of water, and 1 pint per plant). The symptoms of attack are the development on the roots of ugly scabby swellings, Fig. 130.

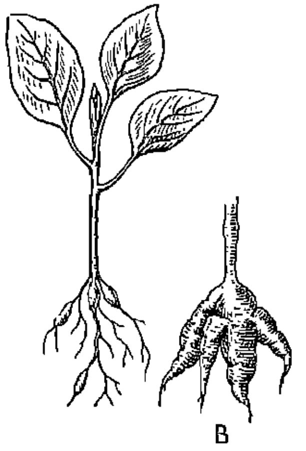


FIG. 130. CABBAGE CLUB ROOT

A. Seedling showing swellings on the root.
B. The clubbing of the roots.

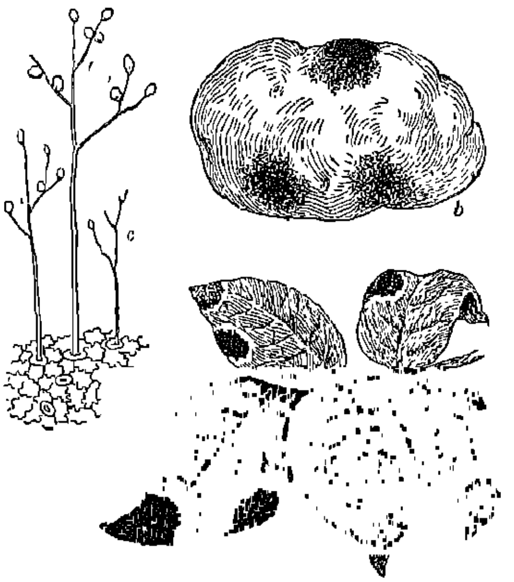


FIG. 131. POTATO DISEASE

a. Leaf with dark-coloured patches and whitish borders showing the progress of the fungus.
b. Tuber with dark-coloured spots.
c. Enlarged drawing of whitish branches of the fungus bearing spores.

Wart disease.—Attacks the potato only, forming on the tuber excrescences very much like a dirty cauliflower. In bad attacks similar swellings may arise on the haulm. No remedy is known, but there are immune varieties, which should, and in many cases must be, by government regulation, grown in infected land.

Common scab.—Attacks potatoes and beetroot, forming superficial brown scabs about the size of a sixpence, Fig. 131. Disfigures but does not affect cropping capacity or table quality. Can be prevented by rotation cropping, and planting the tubers on humus, such as stable manure or leaf mould, which possess a greater attraction for the scab organism.

Late blight.—The potato and outdoor tomatoes are susceptible. The haulm yellows, is covered with brownish white mould, decays, and emits a vile smell. At this stage the disease passes into the tubers, causing demic or decay. An outbreak can be prevented by spraying the haulm with Bordeaux or Burgundy Mixture in early July, and again three weeks later in the event of showery weather.

Celery leaf spot.—The susceptible crops are celery and parsnips. Yellow leaf blotches are followed by complete withering, the trouble spreading with great rapidity.

Sterilisation of the seed destroys resting mycelium that is transmitted on the seed coat. Spraying with Bordeaux Mixture in early August and early September prevents infection from external sources.

Cladosporium.—A serious enemy of tomatoes. Yellow leaf blotches are succeeded by a brownish mould, which completely ruins the crop. *The maintenance of a dry, airy atmosphere is an effective safeguard.* Spraying with ammonium polysulphide solution (1 part in 50 parts of water) is a certain cure.

Blossom end rot.—A tomato disease caused by inadequate watering. The affected fruits, which develop rot spots at the eye end, *should be burned, and more moisture applied* to the roots.

Sleepy disease.—This is another tomato trouble. Stricken plants droop, owing to the operation of the fungus within their roots. Shade affected plants heavily, and, once a week for a month, water into the soil around each plant half a teaspoonful of sulphate of potash.

Cucumber fruit rot.—Affects the fruitlets, causing them to rot. Remove the affected fruitlets and spray with liver of sulphur solution (1 oz. in 3 gallons of water).

Root knot disease.—Attacks cucumbers and tomatoes, forming bladder-like swellings on the roots. Is due to an eelworm. An effective safeguard is to plant in sterilised soil. If the infection is caught in its early stages, diseased plants can be saved by cutting off affected roots, and watering with lime water (2 oz. of lime in a gallon of water) at weekly intervals for a month.

White rust.—A serious disease of wallflowers, alyssum, turnips, and members of the cabbage family. Covers the foliage with felty white mould. *The disease can be destroyed* by dusting thickly with flowers of sulphur.

USEFUL HINTS

Virility of resting spores.—The resting spores of fungi are extraordinarily tenacious of life. They can withstand great heat and *cold, and lie dormant for long periods. Exact* periods have not been determined, but it is known that resting spores may germinate after several years. That is why such *diseases as club root are so difficult to* eradicate.

Liver of sulphur solution.—This solution stains very badly, hence the operator, when using it, should avoid white paint, wear old clothes, and see that his syringe or sprayer is in good order.

Silver leaf disease.—This disease is scheduled under the *Destructive Insects and Pests Order* of the Ministry of Agriculture. Copies of the Order are obtainable on application to the Secretary, Ministry of Agriculture, 10, Whitehall Place, London, S.W. The provisions of the Order should be carefully studied.

Flowers of sulphur and freshly slaked lime.—When this mixture is used for the destruction of diseases, it must be made immediately before the application. Chemical changes quickly bring about deterioration and coagulation, which makes it impossible to distribute the mixture evenly.

The incidence of rust diseases.—Rust diseases are always more prevalent in badly drained soil, no doubt because the host plants are weakened, and are on that account unable to resist attack.

Wart disease of potatoes.—This destructive disease is scheduled under the *Destructive Insects and Pests Order.* Secure a copy of the Order and study its provisions (see silver leaf disease above).

Common scab of potatoes.—Substances of an alkaline nature favour the growth of the organism causing the disease. That is why lime, cinders, and ashes from the fire should never be applied to land immediately before potatoes are planted, or during the season of growth.

Aster wilt disease.—There is some evidence that the resting mycelium of this disease is carried on the seed coat, and that when the seed is treated with flowers of sulphur before sowing, the plants are much more likely to escape attack. Empty the seed into a paper bag, cover it with flowers of sulphur, and shake thoroughly. Do this immediately before sowing, and explain clearly the object of the treatment.

When buying brassicas.—Members of the brassica family should always be carefully examined for traces of club root or gall weevil. Infected or infested stock must on no account be planted.

Late blight disease of potatoes.—In recent years most of the first outbreaks of this devastating disease have been traced to dead haulm left over from the previous season. Take an opportunity, therefore, when dealing with potato troubles, to impress upon the children the necessity for burning all potato haulm as soon as it is dry.

CLASSROOM WORK

Cheshunt Compound.—Following is the formula for Cheshunt Compound:—2 parts powdered copper sulphate, 11 parts fresh ammonium carbonate. The parts are by weight. Mix the two ingredients carefully, store the mixture in a tightly stoppered bottle or jar for twenty-four hours. Draw supplies as needed, and prepare for use by dissolving 1 oz. in 2 gallons of water.

Lime sulphur solution.—The following is the formula:—flowers of sulphur 1 oz., quicklime 1 lb., water 3 gallons. To prepare this solution, slake the lime in a wooden vessel with a gallon of boiling water. Add the sulphur, and two gallons of water. Cover the vessel with a sack, and allow the mixture to boil for twenty minutes. Then strain through muslin, and apply as soon as cool.

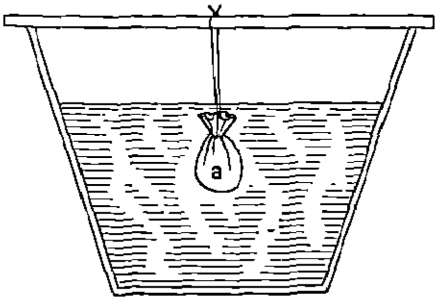


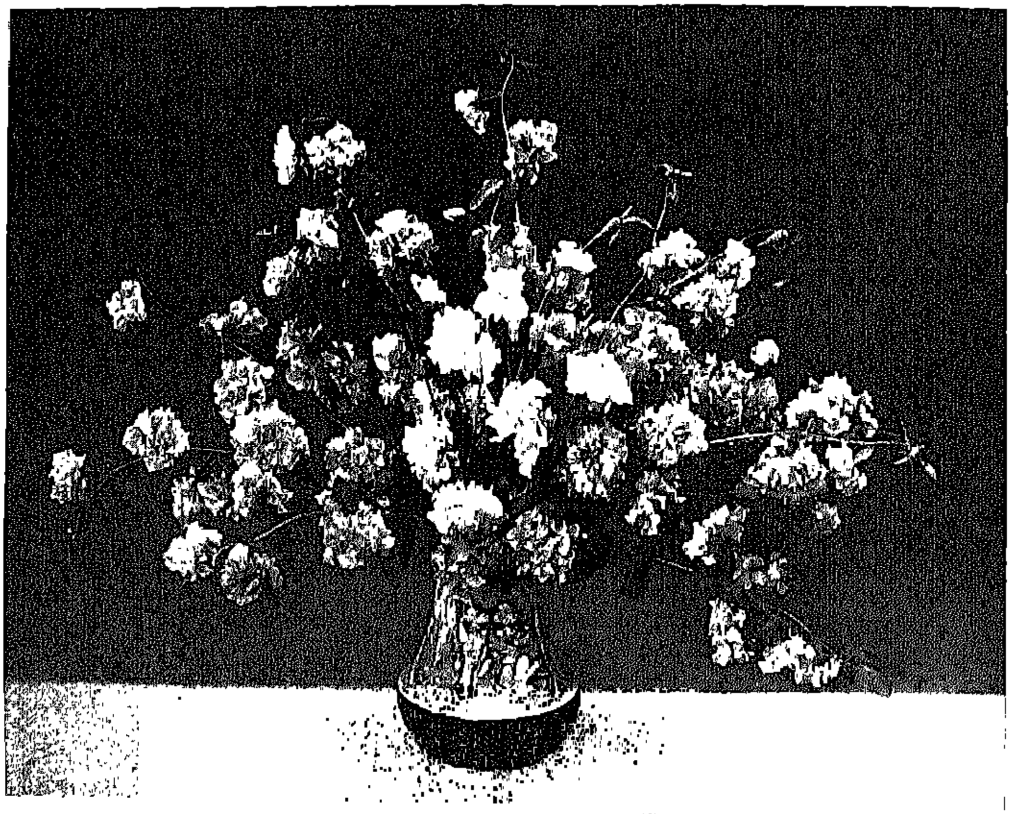
FIG. 132. SHOWING A BAG OF COPPER SULPHATE (*a*) SUSPENDED IN LIME WATER

Bordeaux mixture.—Prepare this mixture in a wooden vessel. Into the vessel empty 4 oz. of lump lime. Pour on the lime half a gallon of water. Now wrap 4 oz. of sulphate of copper in muslin, and suspend the muslin in the lime water. Leave this arrangement over-night, and make up to 2½ gallons with cold water next morning, Fig. 132.

Burgundy mixture.—The following is the formula:—¼ lb. of washing soda crystals, 4 oz. of sulphate of copper, 2 gallons of water. Dissolve the sulphate of copper in a muslin bag in 1 gallon of water, using a wooden vessel. Dissolve the washing soda also in a gallon of water. Pour the soda solution into the copper sulphate solution, and stir thoroughly.

Sterilisation of celery seed.—Stir one medicinal drachm of commercial formalin in 2½ pints of water. Empty the celery seed into a basin. Cover it with this solution, and leave for three hours. Stir every half hour. Then take the seed out, and dry it very slowly. This process kills the resting stage of leaf spot disease, which over-winters on the seed coat.

XI. FLOWER CULTIVATION



CLARKIA

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Hardy annuals.—A hardy annual is a plant which completes its life within one year, and then dies. Many beautiful flowers fall into this class. They are now grown extensively in gardens of every kind, and should be well represented in the school garden. Conspicuously charming subjects in the class are cornflower, calendula, clarkia, godetia, annual chrysanthemum, ursinia, venidium, Shirley poppy, Californian poppy, larkspur, scabious, and candytuft.

Soil preparation.—Where possible this should be carried out in winter, to give alternating frost and thaw an opportunity to improve the texture. Dig one foot deep, incorporating with each square yard a 2 in. layer of well-rotted stable manure and 2 oz. of bone meal. Break down the lumps, tread fairly firmly, and rake the surface even. As the seed is very small, fineness of texture is vital.

Seed sowing.—To maintain a succession of bloom from the end of June until the advent of severe frosts, it is essential to sow twice, at the end of March, and again in mid-June. There are two methods—broadcasting, and sowing in 1 in. deep drills. The former operates when hardy annuals are sown in

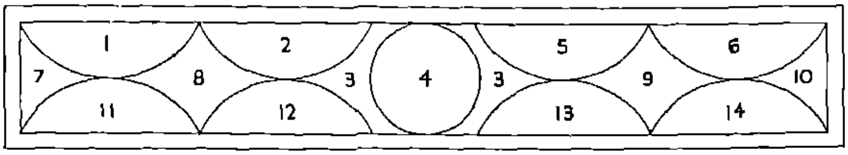

FIG. 133. PANEL DESIGN FOR HARDY ANNUAL BORDER

1, 6. Scarlet Clarkias.
2, 5. Yellow Annual Chrysanthemums.
3, 7, 10. White Cornflowers.
4, 8, 9. Blue Cornflowers.
11, 14. Pink Godetias.
12, 13. Mignonette.

clumps in the herbaceous border or other parts of the garden, or when panel designs are made. These are very pretty, and probably constitute the most effective method of display. The diagrams show appropriate schemes. Having traced the outlines with a pointed stick, scatter the seed thinly on the surface, and just cover it by light raking. Drill sowing is the accepted method when line effects are desired, such as along a bed edge, or in a ribbon border, Figs. 133, 134 and 135.

Early treatment and thinning.—As soon as the seedlings appear, dress them with weathered soot, which expedites growth,

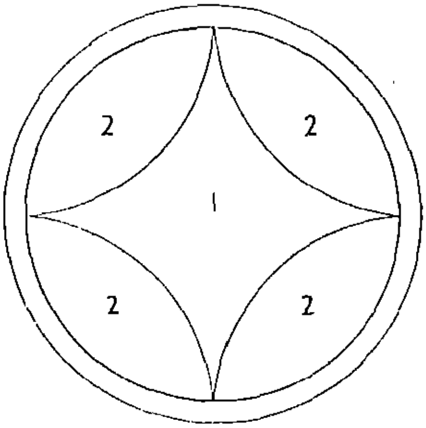

FIG. 134. PANEL DESIGN FOR HARDY ANNUAL BED

1. Orange Calendulas.
2. Blue Nigellas.

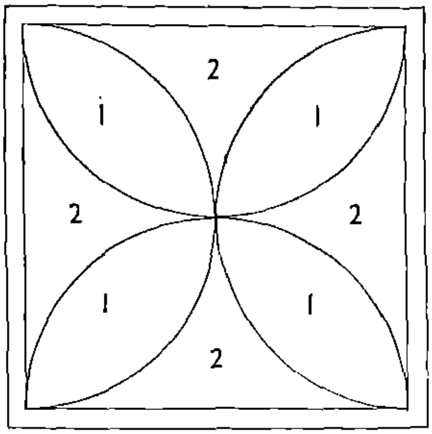

FIG. 135. PANEL DESIGN FOR HARDY ANNUAL BED

1. Pink Larkspurs.
2. White Clarkias.

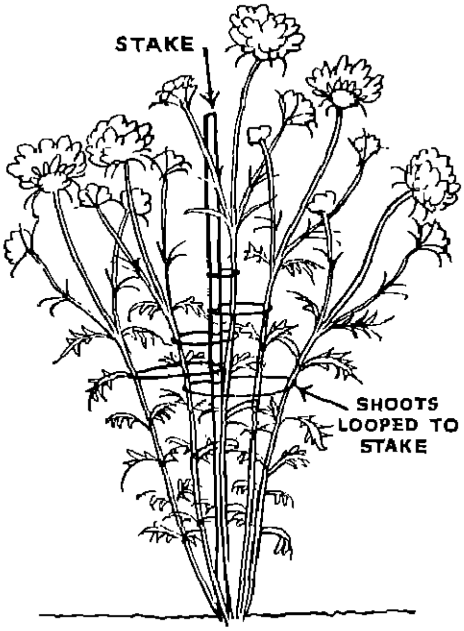

FIG. 136. SHOWING HOW TO STAKE HARDY ANNUAL

Aquilegias

Gaillardia

Pentstemon

Pyrethrum

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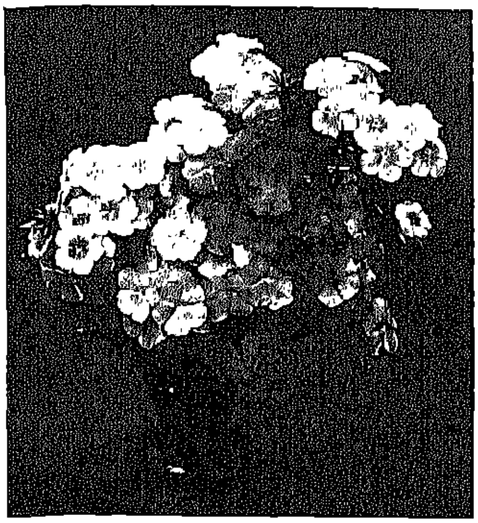

PHLOX DRUMMONDII

DOUBLE GODETIA

CAMPANULA PYRAMIDALIS

NEMESIA

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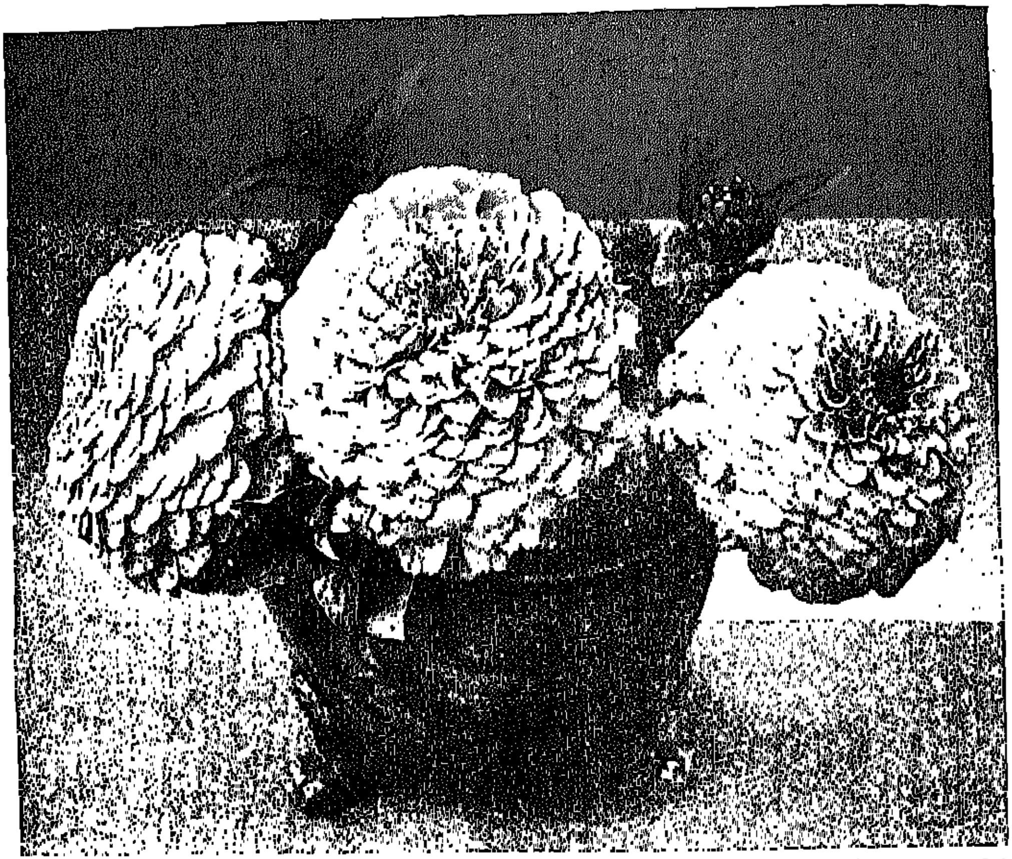

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ZINNIA

and wards off slugs and leatherjackets. Hand weed early, or the little plants will be spindled. Before congestion arises, thin to the following distances:—cornflower, calendula, clarkia, godetia, annual chrysanthemum, larkspur, and scabious 12 in.; ursinia, Californian poppy, and candytuft, 9 in.; venidium and Shirley poppy, 6 in.

Staking.—Many tall annuals need staking. Support the main stem of each plant with a neat stake, and loop the growths separately to it. No hard and fast line can be drawn as to the plants which need this aid. So much depends on season and soil. The cultivator should use his own judgment, seeing that every plant which needs support is accorded it, Fig. 136.

Feeding.—From the time buds show, to the end of the following period, feed fortnightly with quarter strength liquid manure, or with a 1 oz. per square yard dressing of a mixture of 4 parts superphosphate of lime, and 1 part each of sulphate of ammonia and sulphate of potash.

Spent flowers.—Remove these weekly, or bud production will soon cease.

Hardy biennials.—A hardy biennial is a plant which completes its life cycle in two years. As a rule the greater part of the growth is made during the first year, the second being reserved for flowering and seed production. From the gardening standpoint, several plants are treated as biennials which

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A Border of Dahlias and Chrysanthemums

are in fact perennials. When treated as perennials, their beauty declines. The subjects mentioned in this treatise are gardeners' biennials, not botanists'. They are Sweet Williams, Canterbury bells, wallflowers, foxgloves, evening primroses, honesty, cynoglossums, and forget-me-nots.

Preparation of the seed bed.—Biennials are not sown in their flowering quarters, but in a special seed bed which is prepared by forking 1 ft. deep, incorporating a light dressing of leaf mould, spent hops, or prepared hop manure, to encourage vigorous early rooting. Reduce the soil to a fine texture, and make it moderately firm. Choose a partially shaded position, to prevent early embarrassment from too much sun.

Seed sowing.—The ideal period is the end of May, which affords ample time for good growth before autumn. In ½ in. deep drills spaced 4 in. apart, sow thinly, filling up the drills very carefully with pulverised soil. The drill method is better than broadcasting, as it facilitates hand weeding and soil stirring, two urgent early attentions.

Transplanting to nursery beds.—This is a vital phase. It prevents spindling, and ensures the formation of abundant fibrous roots which enable the plants to survive adverse wintry conditions. Choose a sunny situation, make the soil moderately rich, and transfer the plants when they are forming their third or fourth normal leaf. Space them 6 in. apart. Regular soil stirring and watering in dry weather are the only attentions needed in the nursery bed.

Transplanting to flowering positions.—The end of September, when summer flowers are fading, is the accepted time. It is eminently suitable also because it enables the plants to become firmly established before winter. Where the work cannot be done before mid-October, it should be deferred until the following March. Plant forget-me-nots 6 in. apart, the other biennials 12 in.

Hardy perennials.—A hardy perennial is a plant which lives for three years or more. Usually its life is unlimited, provided correct cultural conditions obtain. The class includes many exquisite garden flowers, such as delphinium, lupin, Michaelmas daisy, bocconias, kniphofia, phlox, doronicum, autumn anemone, oriental poppy, flag iris, pyrethrum, geum, gypsophila, and trollius. It is customary to assemble these flowers in one border, calling it a herbaceous border. Too much praise cannot be bestowed on the beauty of the feature, which should never be omitted.

The herbaceous border site.—Choose a conspicuous, sunny, well drained situation. In shade most herbaceous plants are a failure.

Shape and dimensions of border.—The perfectly straight border is not very effective. Far better choose or make one having curving outlines, thus affording many-angled views of the plant's beauty. The length is immaterial, the width should be considered carefully. Generally, borders under 4 ft. wide are unsatisfactory, as are those more than 12 ft. wide. Work, therefore, between the maximum and minimum suggested. The planting design shown in the diagram illustrates an actual border that has received much praise, Fig. 137.

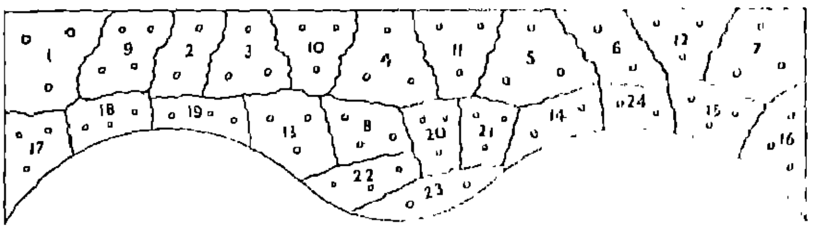


FIG. 137. PLANTING PLAN OF 6 FT. HERBACEOUS BORDER

3 ft. apart.
1. Delphinium Monarch of Wales (blue).
2. Artemisia lactiflora (cream).
3. Oriental Poppy King George (scarlet).
4. Michaelmas Daisy King of the Belgians (mauve).
5. Lupin Goldcrest (yellow).
6. Kniphofia Express (red).
7. Bocconia cordata (cream).
8. Pæony Lady Derby (pink).

2 ft. apart.
9. Phlox Selma (pink).
10. Campanula pyramidalis (blue).
11. Helenium Riverton Gem (red and yellow).
12. Iris Lord of June (blue).
13. Anemone Autumn Queen (pink).
14. Michaelmas Daisy Little Boy Blue.
15. Alstroemeria aurantiaca (orange).
16. Erigeron Quakeress (mauve).

18 in. apart.
17. Pyrethrum Lord Rosebery (crimson).
18. Geum Lady Stratheden (yellow).
19. Campanula persicifolia (blue).
20. Trollius Golden Globe (yellow).
21. Heuchera Pluie de Feu (scarlet).
22. Gypsophila paniculata (white).

23. Nepeta Mussini (blue).
9 in. apart.

24. Pink Mrs. Sinkins (white).
6 in. apart.

Length of border—30 ft.
Maximum width of border—10 ft.
Minimum width of border—6 ft.

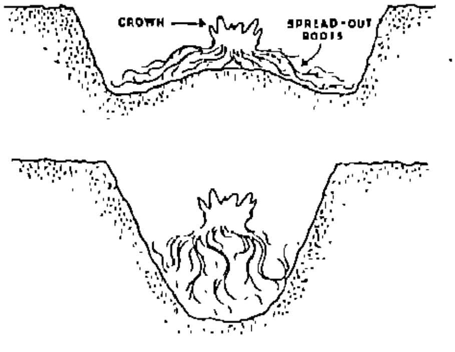
Soil preparation.—Dig 2 ft. deep, mixing with each square yard of both spits ¾ pailful of stable manure. Break down the lumps, tread fairly firmly, and when raking immediately prior to planting, work in a 2 oz. per square yard dressing of bone meal. Prepare the border a fortnight before planting, to allow for soil sinking.

Planting period.—This extends from late October until the end of March. Planting must not, however, proceed when the soil is pasty or frosty. The first month of the period mentioned is the best, because the soil is still warm enough to promote re-establishment before winter. The plants are thus able to bear up against spring drought better than if they were planted late.

Method of planting.—For each plant make a hole wide enough to receive the roots comfortably. Spread out the fibrous roots of subjects such as Michaelmas daisies, stretch straight down the tap roots of plants like delphiniums. In all cases bury the crowns or root tops an inch deep, Figs. 138, 139, 140, 141.

Transplanting.—Herbaceous plants are happy in the same situation for three years, at the end of which they must be transplanted to provide for the re-enrichment of the soil and the division of overgrown specimens. November to March is an excellent period for this work.

Herbaceous border management.—The management of a growing herbaceous border involves some care. The young shoots are often attacked by slugs in spring, unless each plant is surrounded by a one inch high cordon of small, sharp cinders, or a similar cordon of a mixture of 5 parts powdered kainit and 1 part powdered bluestone or sulphate of copper.



FIGS. 138 AND 139. PLANTING A FIBROUS-ROOTED HERBACEOUS PLANT

The top diagram shows the correct method of planting a fibrous-rooted herbaceous plant.
The lower diagram shows the incorrect method. The roots are squeezed into too small a space.

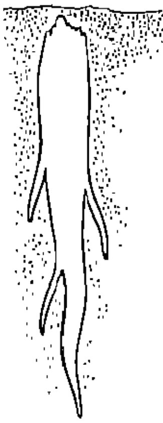


FIG. 140
CORRECT METHOD OF PLANTING TAP-ROOTED HERBACEOUS PLANT. TAP-ROOT STRETCHED STRAIGHT DOWN

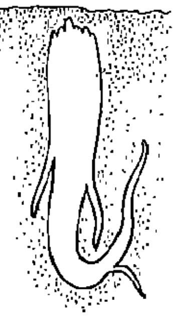


FIG. 141.
INCORRECT METHOD OF PLANTING TAP-ROOTED HERBACEOUS PLANT. NOTE TWISTED TAP-ROOT

Shoot reduction.—Many plants, such as Michaelmas daisies, phloxes, heleniums, sunflowers, golden rods, and rudbekias develop far more shoots than they can flower properly. Reduce the shoots to six of the best per plant when they are 4 to 5 in. long. Cut off the redundant shoots where they arise on the crowns, to prevent the development of secondary growths from the left-in stumps.

Staking.—Most herbaceous subjects need staking, or growth becomes permanently mis-shapen. Apply the stakes when it is evident that the plant concerned can no longer support itself. Use one stake for each shoot of vigorous growers such as hollyhocks and delphiniums, three stakes for each plant of less vigorous habit, like phloxes and heleniums. Enclose the growths of the latter in encircling raffia or fillis string ties, in all cases preserving the natural deportment of the plant.

Maintenance of soil texture.—Whenever the soil shows signs of caking, ply the Dutch hoe. Fork 4 to 6 in. deep in mid-July, to mitigate the effects of the trampling inseparable from constant cultural attentions.

Autumn treatment.—When inclement weather ends the display, cut down each plant to within 3 in. of the soil level, burn the growth to destroy pests and diseases, and dig between the plants, working in a 3 in. layer of well-rotted stable manure. No further attention is needed until growth starts in spring.

Roses.—There are many members of the rose family. Those generally cultivated in gardens are dwarfs (including hybrid teas, hybrid perpetuals, and dwarf polyanthas), ramblers, climbers, and weeping and upright standards. Dwarf roses are used for planting in beds and borders; ramblers and climbers for clothing arches, fences, and walls; weeping and upright standards as "dot" subjects in beds, borders, and lawns.

Planting situation.—Roses will not thrive in shade, and are most impatient of draughts and indifferent drainage. They like full sun, reasonable shelter, with no superfluous water around their roots.

Soil requirements.—Contrary to the general belief, heavy manuring is not desirable at planting time. The roots establish themselves better in rather poor conditions. Feed generously after they *are* established. The ideal method is to work the soil 2 ft. deep. With each square yard of bottom 1 ft. layer, mix ½ pailful of strawy stable manure, with the top layer no stable manure, but a 2 oz. per square yard application of bone meal. Work the soil to a fine texture, and tread it firmly.

Planting period.—This extends from the end of October to the end of March. The

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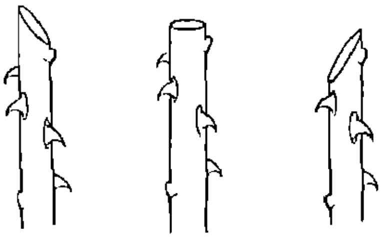
LAVATERA IN THE HON. MRS. BORTHWICK'S HOME, WOODCOTE HOUSE same suggestions apply as to herbaceous plants.

Planting distances.—Space hybrid tea and hybrid perpetual varieties 18 in. apart, dwarf polyantha 15 in., ramblers and climbers 6 ft., standards as the lay-out determines.

Planting method.—Rose roots often suffer in transit. When they arrive, cut off the damaged parts, and soak the sound roots in water for twenty minutes to replace lost sap. Make each planting hole wide enough to receive the spread out roots comfortably, and deep enough just to bury the budding point on the main stems of hybrid teas and hybrid perpetuals. The roots of other sections should be buried 2 in. deep, Fig. 142.

Pruning hybrid teas and hybrid perpetuals.—Late March, after the danger of severe frost is past, is the appropriate period. Shorten each shoot of vigorous growers half way back, of weak growers to within two buds or eyes from the base. The object of this differential treatment is to restrain the vigorous, and invigorate the weak, encouraging both to produce flowering growth. Make slanting cuts immediately above the selected bud or eye, Figs. 143, 144, 145, 146, 147.

Pruning dwarf polyanthas.—Late March is the best time. Cut out entirely the weak side shoots, and shorten the remainder one third of the way back. If there is old exhausted growth, cut that out also.



Figs. 145, 146 and 147
Pruning a Rose

The first illustration shows the correct type of slanting cut. The base of the cut is immediately above the eye.

The second illustration shows another incorrect type of cut. Water lodges on the horizontal surface.

The third diagram shows an incorrect method of slanting cut. The base of the cut is below the eye, and thus the sap cannot ascend to the eye.

Pruning ramblers.—Rambler roses flower on one year old wood, which having flowered, becomes redundant. Cut it out entirely if no young shoots arise towards the base. If they do, make the cut immediately above the point at which the young originates. Immediately after the flowers fade is the appropriate period, Fig. 148.

Pruning climbers.—Shorten half way back in late March the side shoots on the main branches. If there is unripened wood at

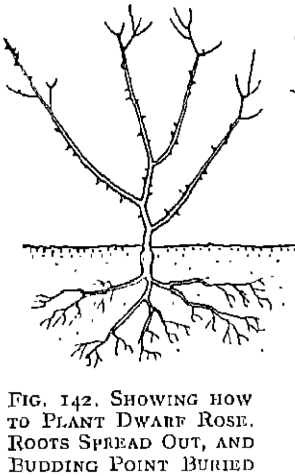


Fig. 142. Showing how to Plant Dwarf Rose. Roots Spread Out, and Budding Point Buried

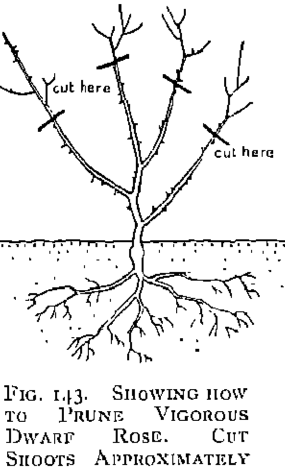


Fig. 143. Showing how to Prune Vigorous Dwarf Rose. Cut Shoots Approximately Half Way Down

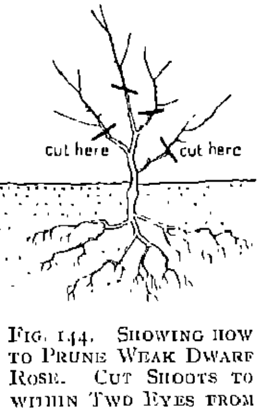
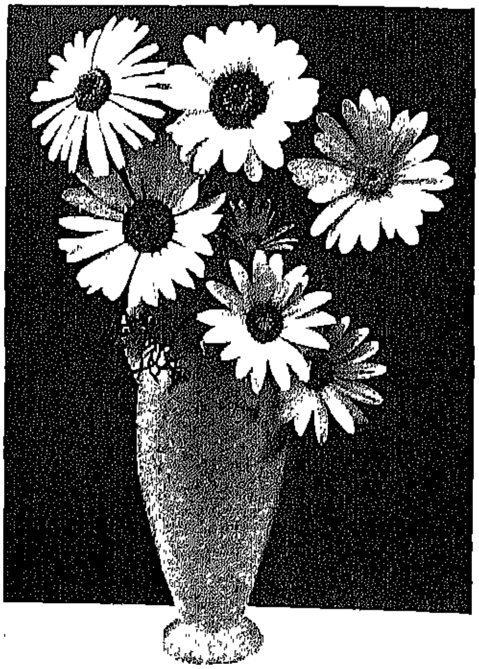
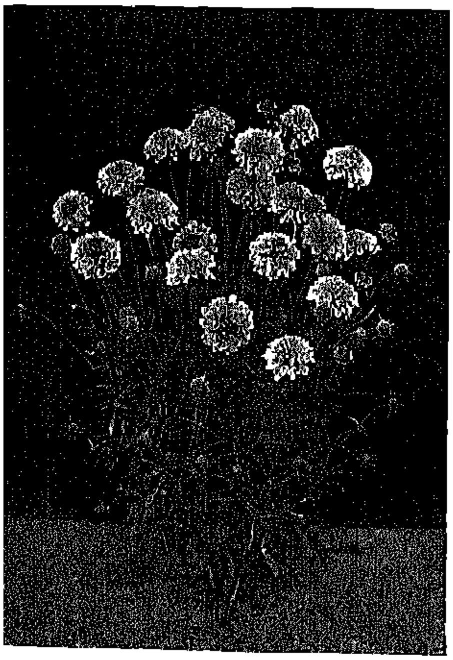


Fig. 144. Showing how to Prune Weak Dwarf Rose. Cut Shoots to within Two Eyes from Base

Annual Chrysanthemums



Ursinia Hybrids



Scabious

Coreopsis

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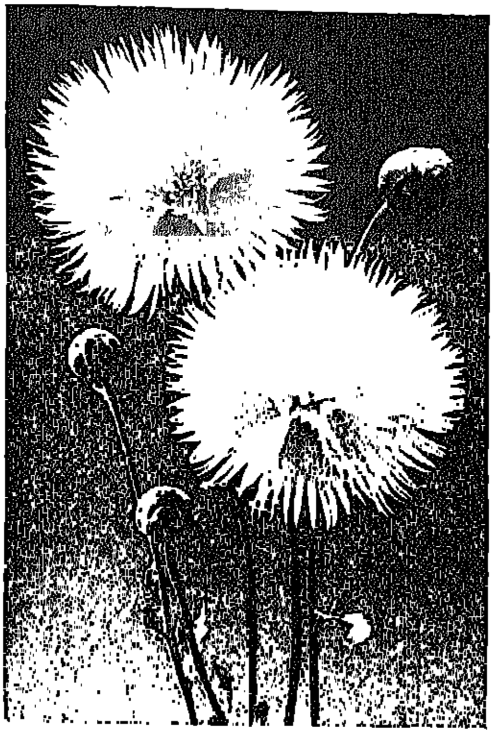
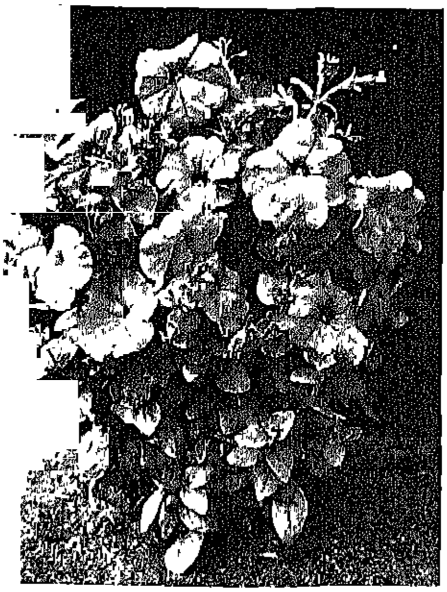
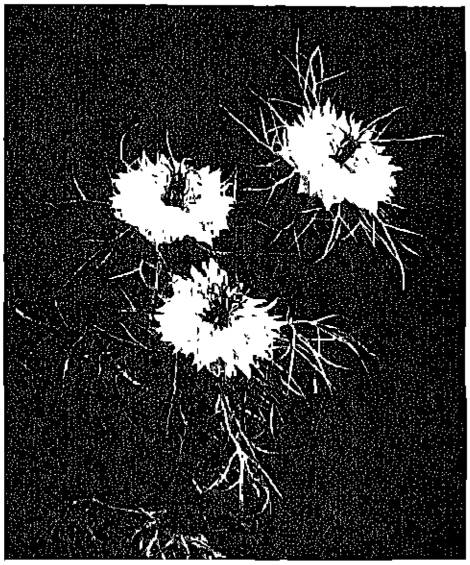
SALPIGLOSSIS



DOUBLE SWEET SULTAN



PETUNIAS



NIGELLA

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the tip of the latter, cut it off. Otherwise, do not touch these branches.

Pruning weeping standards.—Proceed on similar lines to those suggested for ramblers. Cut out as much old flowered growth as can be spared having regard to the necessity for leaving an abundant supply of young.

Pruning upright standards.—In late March shorten the side shoots half to two-thirds of the way back, in accordance with their vigour, the weaker ones to be treated the more severely.

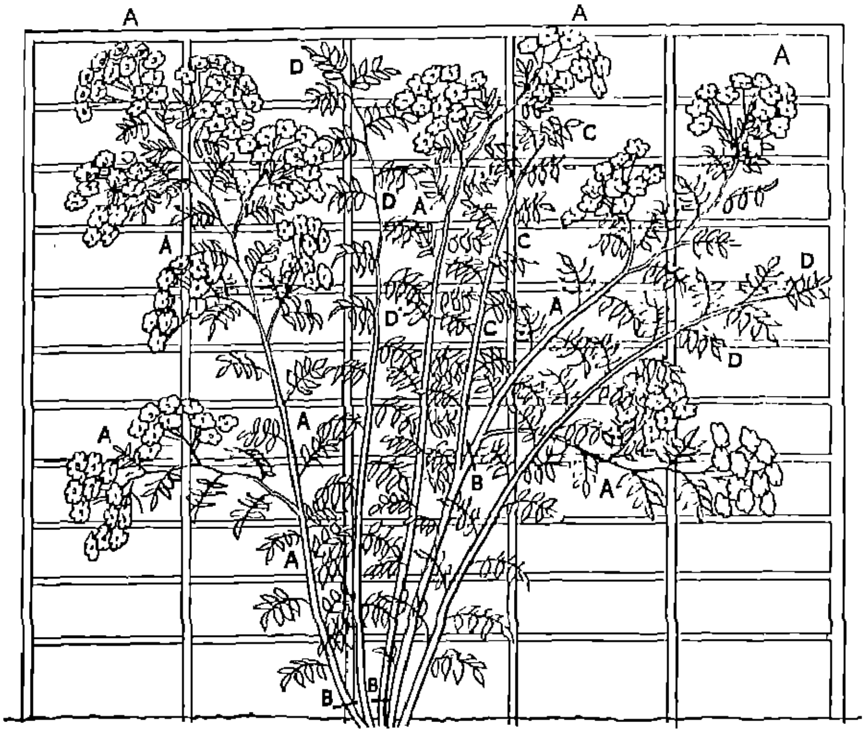


FIG. 148. PRUNING RAMBLER ROSE

A. Flowered branch.
B. Cut here.
C. Young shoot.
D. Suckers, to be left.

Removal of suckers.—Hybrid tea, hybrid perpetual, climbing, and upright standard roses are budded on to briar or rugosa stocks which at any time may throw up suckers or robber growths. These must be promptly removed, or they will destroy the variety. They arise from the roots of the two first named sections, but may grow out of the stem as well as from the roots of climbers and upright standards.

Feeding.—All sections of roses need generous feeding. From early May until the end of September apply quarter strength liquid manure weekly, or a mixture of the following artificial fertilisers at similar intervals:—superphosphate of lime 6 parts, sulphate of potash 2 parts, sulphate of ammonia, sulphate of lime, and sulphate of magnesia 1 part each. Apply the latter mixture at 1 oz. per square yard, or one teaspoonful per individual specimen, whichever is the more convenient.

Autumn treatment.—After raking up fallen leaves, and cutting off spent blooms, fork the beds a foot deep and mulch with a 3 in. layer of strawy manure to protect the roots during winter. Do not allow the manure to assume actual contact with the stems, or it may cause canker.

Ornamental shrubs.—Ornamental shrubs are divided into two sections, deciduous or leaf-shedding, and evergreen. A proportion of both should be planted, to ensure the maximum beauty in both winter and summer. All deciduous shrubs that are worth growing flower at some season. The following is a representative selection:—Daphne mezereum (rosy purple, March) Ribes sanguineum (red, April) Berberis stenophylla (orange, May), Lilacs in variety (May and June), Philadelphus Virginale (white, July) Buddleia Veitchiana (purple, August). Evergreen shrubs are divided into two sections, flowering and non-flowering. The latter are grown for the beauty of their foliage, and include Aucuba japonica, green and variegated hollies, cherry laurel, Skimmia japonica, and conifers of all kinds. Evergreen flowering shrubs have as a rule little foliage charm to recommend them, but they bear lovely flowers. In this class are Berberis Darwinii (orange, May), Choisya ternata (pinkish white, June), and Veronicas of various kinds, bearing blue, purple, pink or white flowers from July to October.

The arrangement of shrubs.—Where space permits, a shrubbery should be planted. Where it does not, the shrubs should be spaced at intervals through the borders. Their presence as permanent and dignified features is necessary to an attractive lay-out. The diagram shows a beautiful shrub planting scheme, Fig. 149.

Preparation of soil.—Prepare the soil on exactly the lines suggested for the herbaceous border. Generous measures must prevail.

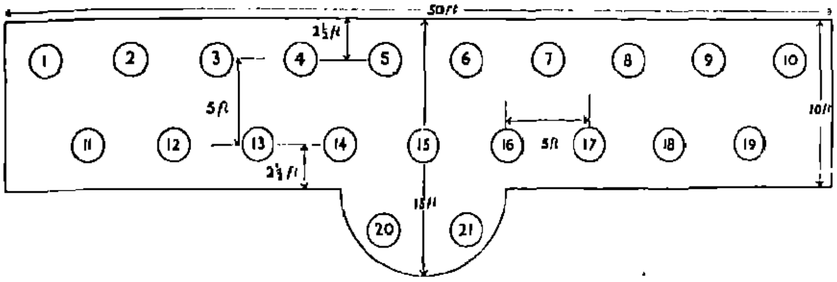


Fig. 149. PLANTING PLAN OF SHRUBBERY

1. Lilac Madame Lemoine (double white).
2. Cupresses Lawsoniana (evergreen).
3. Buddleia Veitchiana (purple).
4. Philadelphus Virginale (white).
5. Holly Golden Queen (evergreen).
6. Lilac Alphonse Lavallee (blue).
7. Berberis Darwinii (orange).
8. Choisya ternata (pinkish white).
9. Holly Silver Queen (evergreen).
10. Lilac Charles X (red).
11. Ribes sanguineum (red).
12. Aucuba Japonica (evergreen).
13. Diervilla rosea (pink).
14. Skimmia Japonica (evergreen).
15. Cytisus Moonlight (pale yellow).
16. Veronica Autumn Glory (blue).
17. Ribes aureum (yellow).
18. Cherry Laurel (evergreen).
19. Escallonia Langleyensis (pink).
20. Daphne mezereum (pink).
21. Hydrangea paniculata (cream).

Length of border—50 ft.
Maximum width of border—15 ft.
Minimum width of border—10 ft.

Planting period.—The ideal period for planting deciduous shrubs is late October to the end of March; for evergreens, April. The latter are at that season forming vigorous young shoots which enable them to take hold of their new quarters without serious leaf shedding.

Pruning deciduous shrubs.—The method depends entirely on the wood on which flowers are produced. In shrubs belonging to the Ribes class, for instance, they develop on short side shoots, which should be cut half way back immediately after flowering, to prevent the inordinate lengthening of the side shoots which bear flowers only at their tips. Shrubs of the Philadelphus group produce their flowers on one year old wood, which after flowering becomes superfluous. Pruning, therefore, consists of shortening this flowered growth back to the point at which young shoots arise. In all cases prune immediately after flowering, to reduce the strain on the roots and admit sun and air to ripen the wood.

Pruning evergreen shrubs.—There is no orthodox method here, but each April and September every shrub must be overhauled. Remove the worst of each two crossing branches, dead and weak wood, and branches which straggle beyond the general outline. Evergreens that are being grown as specimens, such as hollies and conifers, must have their leading or apical shoot carefully preserved. If that is cut off, growth develops vigorously lower down, and training becomes impossible. Sometimes these specimens develop a forked leader. There are two shoots where there should be one only. When this occurs, cut off the less promising of the two, Fig. 150.

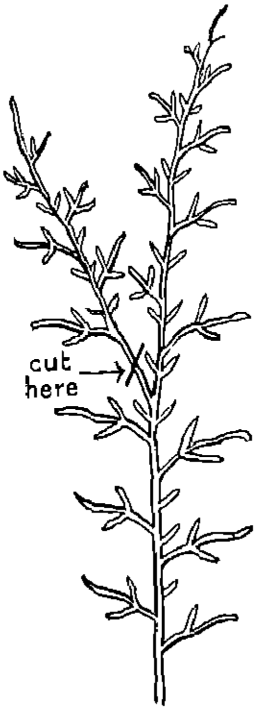


Fig. 150.
Shrub with Forked Leader

USEFUL HINTS

Autumn-sown hardy annuals. — Hardy annuals sown in August in sheltered positions winter quite well out of doors, and flower in early spring. Strictly speaking, the plants become biennials when treated in this way, but it is customary still to regard them as annuals.

Hardy annuals in herbaceous border.— When clumps of hardy annuals are sown in the herbaceous border, it is necessary to consider the colour scheme carefully. Make sure that the hardy annuals do not produce a discord with near-by herbaceous plants, otherwise the introduction will be a disadvantage rather than a help.

Saving seed of hardy annuals.—When a hardy annual of out-standing merit appears, do not remove the faded flowers. Cover the plant with muslin, to prevent cross pollination, and allow the seed vessels to fill, and the seeds to ripen. Qualities to look for are good colour, perfect habit, and profusion of flowering. Plants possessing them often arise unexpectedly.

Sowing biennials.—Adhere strictly to the end of May sowing rule, otherwise the plants will not be vigorous enough to withstand winter. Many a failure is traceable to late sowing.

Shade plants.—Though the majority of herbaceous perennials demand full sun, a few succeed in partial shade, namely, doronicums, spiraeas, paeonies, autumn anemones, anchusas, hemerocallis, flag irises, and Michaelmas daisies. It is possible with the aid of these subjects to assemble quite a nice border in a shady spot.

Preparation of herbaceous border.—If the surface soil and subsoil are very heavy, mix sufficient sand with them to ensure porosity. The soil in these borders is not worked much, hence the necessity, under tenacious conditions, to use an efficient mechanical opener.

Planting evergreens.—If the weather is very bright immediately after evergreens are planted, the leaves droop, because the roots are not active enough to keep them supplied with moisture. It is bad practice to water unless the soil is very dry. Drooping can be prevented by spraying the plants daily with aired water until the leaves are able to stand firm unaided.

CLASSROOM WORK

Hardy annuals for cutting.—Make a list of hardy annuals which in addition to having garden decorative value, are useful for cutting. In this category are calendulas, clarkias, annual chrysanthemums, godetias, cornflowers, larkspurs, candytuft, scabious, ursinias, and Californian poppies.

Disbudding hardy annuals.—Certain hardy annuals such as calendulas, annual chrysanthemums, and carnation and begonia-flowered poppies bear much better blooms when disbudded. A cluster of buds forms at the end of each shoot—one large bud and several small subsidiaries. Remove the latter with the point of a penknife blade as soon as they are large enough to handle. Bring a typical budded shoot into the classroom and demonstrate the process.

Selection of herbaceous plants.—Make a list of herbaceous plants that produce a succession of bloom from April until October, explaining that any border in which this succession is not present lacks completeness. The following is a suitable selection:—April, doronicums and polemoniums; May, pyrethrums and paeonies; June, flag irises, geums, lupins, and oriental poppies; July, delphiniums, anchusas, alstroemerias, and hemerocallis; August, phloxes, heleniums, solidagos, and aconitums; September, kniphofias, hollyhocks, and early Michaelmas daisies; October, late Michaelmas daisies, sunflowers, artemesias, and rudbeckias.

Rose pruning.—Bring into the classroom, shoots of dwarf roses, and explain the reason why when pruning a slanting cut is made, namely, to prevent water lodging on the wood and causing die-back. Explain also why the inter-nodal cut is unsuitable, namely, sap cannot pass the last leaf bud, hence snags left on must die and ultimately cause further die-back also.

Rose feeding.—Where artificial fertilisers are used, mix the ingredients in the classroom. The parts of every formula are by weight. Rub each ingredient through a small sieve to take out the lumps, and mix two or three times.

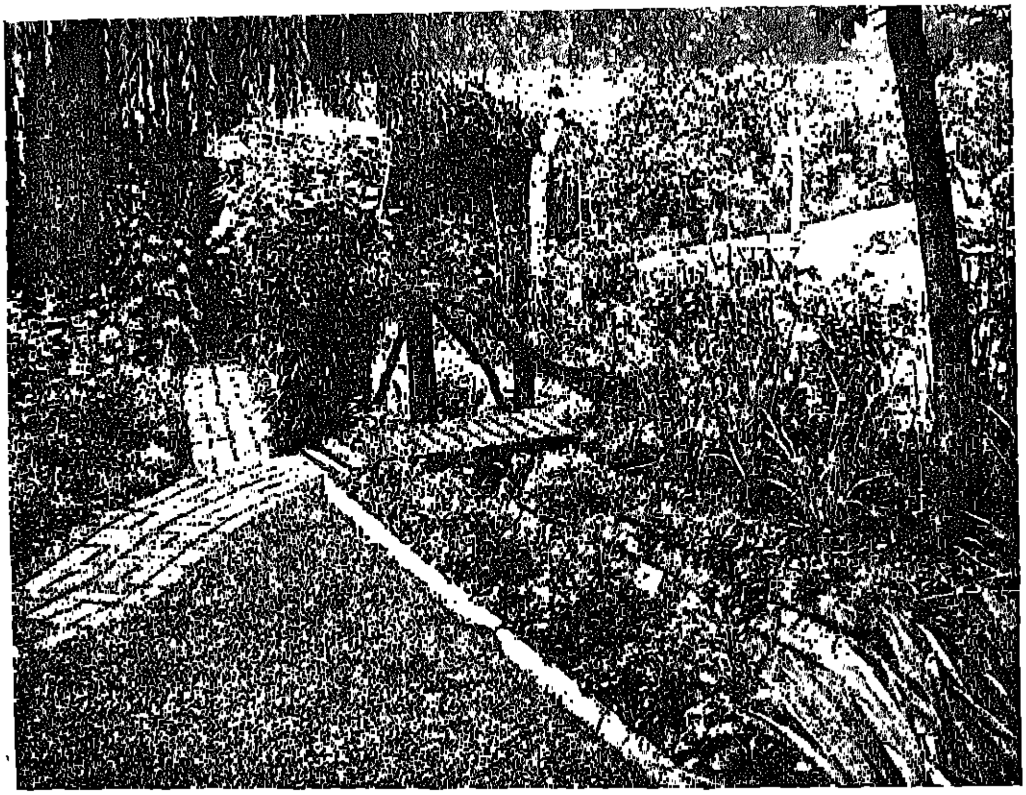
A humorous poem :

SWEET PEA CULTURE

Prepare the ground in Autumn
  And sprinkle lime about;
Give the soil time to settle
  Before you plant them out.
The trenches should be three feet deep
  And also two feet wide,
With bone-meal, soot and farm manure
  Mixed with the soil inside.
You'll find that mid-September
  Is the proper time to start;
Thin out the plants until they stand
  Just half a foot apart.
Be careful how you drain the soil
  Put sand along each row—
But, Gladys, she just shoves them in,
  And, golly, how they grow!

Reginald Arkell.

XII. LAWNS AND LAWN MANAGEMENT, ROCKERY CONSTRUCTION AND THE CULTIVATION OF ALPINES



[Photo: T. Alec Brown

A QUIET CORNER OF A BEAUTIFUL GARDEN

The lawn.—A well-kept lawn is the glory of the flower garden. It provides a perfect setting for shrubs, roses, herbaceous, and bedding flowers. At least one-third of the ornamental area should be laid down to grass. There are two methods of forming a lawn, which after the preparation of the site has been dealt with, will be treated separately.

Preparation of the site.—Dig at least 1 ft. deep, incorporating with each square yard one pailful of well-rotted stable manure and 3 oz. of bone meal. This treatment is more generous than that often accorded. It is in keeping with the findings of modern research, which prove that in the past lawn sites were inadequately manured. Remove stones larger than a golf ball, and perennial weed roots. Break down the lumps, and get an even surface as far as possible. Afterwards roll, make any necessary adjustments in the level, and reroll. Firmness is very essential.

Sowing lawn seed.—There are two accepted periods—August and April. August is more generally favoured, because morning dews expedite germination. Choose a calm day, as wind upsets the distribution rate. Sow 1½ oz. of seed per square yard, covering it with ¼ inch of riddled soil. Afterwards roll lightly.

Early treatment.—If dry weather prevails before the grass reaches 2 in. tall, water generously, as not until this height is reached are the roots able to draw moisture from beneath the surface layer. Hand weed if necessary, standing on a raised platform to prevent heeling of the surface. When the grass is 2 in. tall, clip back to 1 in. This is the only clipping needed by August-sown lawns before winter. The following spring the mower can be used in the ordinary way. Spring-sown lawns should be clipped with hedge shears three times before being cut with the mower.

Turfing a lawn.—Select reasonably weed-free, closely knitted pasture turf. Lift it with a turfing iron in strips 2 in. thick, 2 ft. long and 1 ft. wide. Uniform measurements are a great help in ensuring an even surface.

Laying the turf.—Mild, comparatively dry periods between the beginning of October and the end of March are best for this purpose. Start at one end of the prepared site, lay the turves side by side, press them into position with a flat rammer, fill up the cracks between the turves with fine soil, to provide a bridge over which the roots can knit. Lastly, roll well, and cover the surface with ½ in. of equal parts well-rotted manure and fine soil, to feed the roots and prevent the development of bare patches.

Feeding established lawns.—In early March every year apply a 1 oz. per square yard dose of a mixture of superphosphate of lime 4 parts, sulphate of ammonia and sulphate of potash 1 part each. Water after the application to dissolve the mixture and prevent temporary turf burning. Each July apply a mixture of 4 parts sand and 1 part sulphate of ammonia at 2 oz. per square yard; water the dressing in. The two applications maintain a lawn in perfect condition from the nutritional standpoint.

Mowing.—The lawn mower must be in perfect condition, otherwise it will ladder or bruise the turf. Oil the bearings before every mowing, not on the grass, or oil droppings will kill the turf. Do not mow in wet weather. Commence mowing in early April, cease in early October. In very dry weather, mow without the grass box, allowing the cuttings to be sprinkled over the surface as a cooling, moisture-retaining mulch.

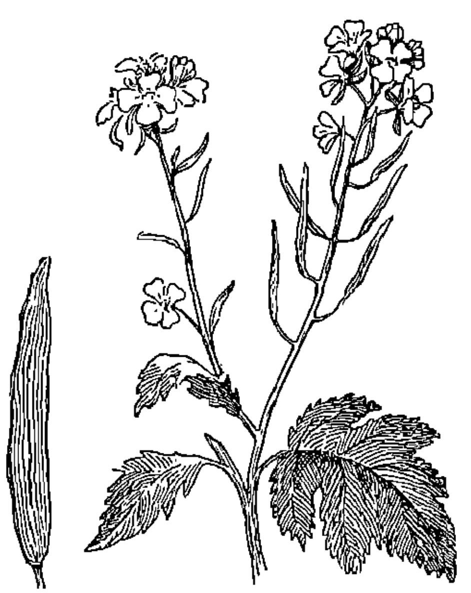


FIG. 151. FLOWER AND FRUIT OF CHARLOCK

Charlock is a common weed of the "cross-bearer" family.

Rolling.—During spring, roll once a week, in summer once a fortnight, in autumn and winter whenever the ground is dry enough to take the roller without the implement picking up soil amongst the turf.

Spiking.—This process admits air to the soil, which must be firmed by continual rolling, to maintain an even surface. Small lawns can be spiked by pushing in the tines of the garden fork 4 in. deep, large lawns by the use of a spiked roller. The operation should be performed monthly during spring and summer, at two-monthly intervals during autumn and winter.

Weeding.—Daisies (Fig. 152), common lawn weeds, can be destroyed by sprinkling the foliage thickly with lawn sand. Dandelions (Fig. 153) and plantains must be cut out with an old table knife. Into the hole vacated by each dandelion drop a pinch of sulphate of ammonia to kill the left-in stub of the tap root, which is inaccessible to the longest knife blade. Kill moss by watering with permanganate of potash solution (¼ oz. in 2 gallons of water, and 1 gallon per square yard). Exterminate clover by dressing it thickly with a mixture of 20 parts sand, 2 parts kiln-dried sulphate of iron, and 1 part sulphate of ammonia. Apply this and the lawn sand for daisies in dry weather. The appearance of weeds need not be regarded as a sign of bad management, but as a natural process due to the dissemination

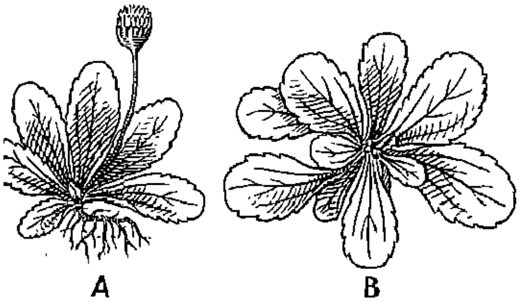


FIG. 152. THE COMMON DAISY

A. The plant, showing root, leaves and flower.
B. Plan of the daisy showing how the leaves are arranged to get as much light and air as possible.

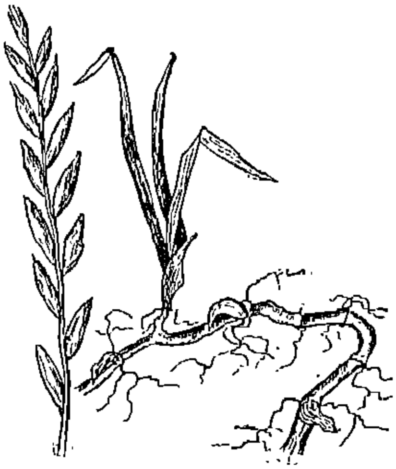


FIG. 154. COUCH GRASS SHOWING UNDERGROUND STEM, ROOTS, LEAVES AND EAR

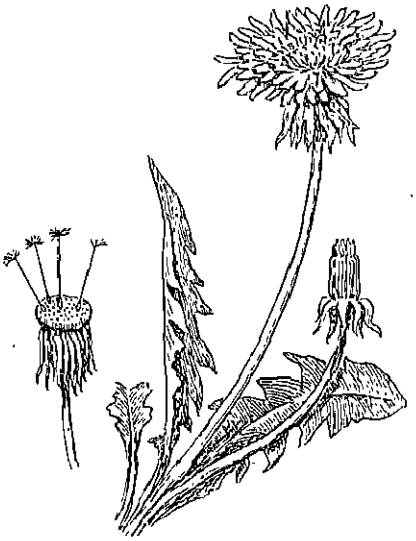


FIG. 153. COMMON WEEDS—THE DANDELION

Each seed is hung at the end of a little feathery parachute a number of which make up the Dandelion "clocks."

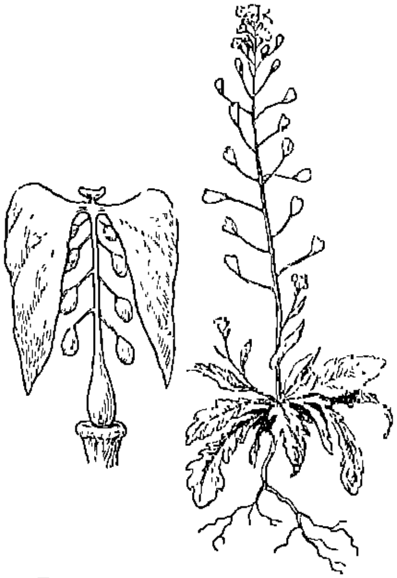


FIG. 155. COMMON WEEDS—THE SHEPHERD'S PURSE

Notice how the "purse" scatters its seeds.

of the seeds of indigenous species amongst the grass.

Repairing lawns.—Undertake this work as soon as mowing ceases in autumn. Cut out bare patches and fill them with accurately cut pieces of good turf. Into the crack between the new and the old turf, place soil to act as a bridge over which the roots from both sides can cross.

Lawn diseases.—"Fairy" rings may appear, due to the activities of a fungus. The grass dies in a circle, the latter gradually spreading outwards as the range of the fungus increases. Destroy the latter by watering with sulphate of iron solution (¼ oz. of the crystals in 2 gallons of water, and 1 gallon per square yard). Mildew, a leaf-whitening disease, attacks the turf in showery weather. A good remedy is to sprinkle thickly with flowers of sulphur.

Lawn pests.—Earthworms, though beneficial in cultivated land, are enemies to the lawn, because they throw up unsightly, turf-fouling soil casts. They can be destroyed by sprinkling mowrah meal on the surface at 4 oz. per square yard. Water it in, using 2 gallons per square yard. In a very short time the worms wriggle to the surface and die quickly. They should be collected and burned. Leatherjackets sometimes attack the roots and commit great devastation. Dressing with lead arsenate at 2 oz. per square yard destroys them. This is a poison, and must, therefore, be handled and stored cautiously.

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Rock and Water Garden

The rockery.—Rockery or alpine gardening is a comparatively modern feature which we owe to the great work done by plant collectors in the Near and Far East. It provides for the cultivation of a wide range of alpine plants, including primulas, alyssums, saxifrages, campanulas, gentians, phloxes, lithospermums, helianthemums, thymes, sedums, aubrietias, and ramondias.

The selection of the stone.—This is an important matter. It is an offence against the highest landscape gardening law to introduce stone different from that in the geological formation of the district. Thus sandstone, millstone grit, or limestone should be used as local circumstances determine. An important proviso that must be made is that the stone selected must be hard enough to weather well.

The selection of the site.—As a rule rockeries do not look well in the middle of a lawn. They should have an end or corner position with, if possible, a background of trees. The site must be sunny and naturally well drained.

The preparation of the site.—Dig 1 ft. deep, working into the trench a 2 in. layer of rubble if the soil is at all heavy, otherwise water might, in specially wet times, back up, flood the plants, and kill them. Many an otherwise good rockery has been permanently damaged in this way. After digging, tread firmly or roll, and wait a fortnight before putting down the stone, to allow for sinking.

The construction of the rockery.—Convey the equipment to the site. For every ton of stone, one ton of good soil is needed for packing. Work to no design. Visualise some hill in the district, and try to reproduce it in miniature. First lay a course of stones, fill up the middle with soil, then lay another course, fill up again, and so on until the rockery is completed. Each stone must be buried half its depth, and it should tilt slightly backwards so that water is conveyed to the plants near by, and not away from them. See that the striae in the stones are laid horizontally or nearly so. An unpardonable fault is committed if the striae incline sharply. Fill up all cavities between the stones with soil. These are known as pockets, and it is in them that the plants grow.

Planting a rockery.—September and October, March and April are the recognised periods. It is advisable to raise or purchase plants in pots, as when they are lifted straight from the open ground there is a risk of serious root disturbance, which may be reflected in the death of the plant concerned, and in any case it will cause serious embarrassment. Plant firmly, and if the weather is dry, water daily until growth restarts.

Choice of planting positions.—It is obvious that the natural irregular way in which stones are laid create shallow, deep, shady, and sunny pockets. Select a suitable plant for each. Thus, primulas, alyssums, and aubrietias like deep shady pockets; ramondias shallow and shady; encrusted saxifrages, helianthemums, campanulas, lithospermums, and gentians, deep sunny pockets; phloxes, thymes, and sedums shallow and sunny. Careful planting on these lines ensures greater success.

The propagation of alpines from seed.—Most alpines can now be raised from seed, which should be sown in shallow boxes of sandy soil in the cold frame in April. When the seedlings are large enough to handle, set them separately in thumb pots, using rather richer compost. Plunge the pots to the rim in small, sharp cinders in a sunny spot out of doors. Weed and water them carefully, and by September they will be ready for planting in the rockery.

The propagation of alpines by division.—Plants of the rosette type, such as campanulas and saxifrages, are easily increased by lifting overgrown plants, splitting them up into small pieces, and replanting straight away. September and October, March and April are suitable periods for this work. On an average the plants in this group need dividing every three years, though where it is desired to propagate rapidly, division may take place every season.

The propagation of alpines by cuttings.—Plants forming clearly defined shoots such as helianthemums, aubrietias, and gentians can be propagated by means of 2 in. long cuttings, which should be inserted during April and May in a 4 in. deep, well-drained bed in a sunny cold frame. Shade the glass lightly for a week or two, keep the frame closed and water carefully. When the cuttings are rooted, set them separately in thumb pots; and treat them as suggested for seedlings.

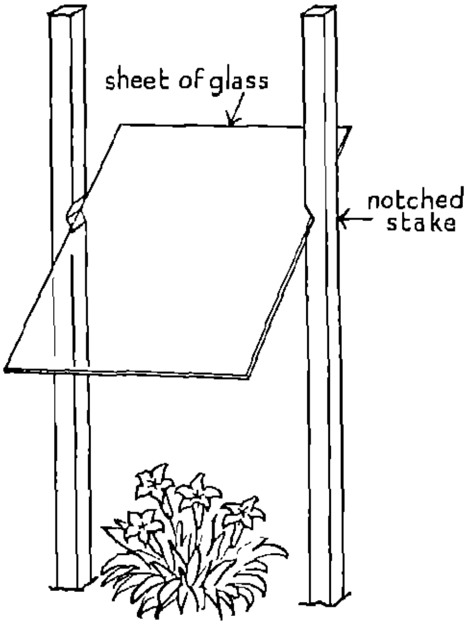


FIG. 156. SHOWING METHOD OF PROTECTING CHOICE ALPINES IN WINTER

The control of slugs.—Slugs are serious rockery pests. They find the stones excellent harbour. Pieces of inverted orange or grape-fruit rind, lettuce leaves, and patches of bran covered by a tilted slate make effective traps, while visits made with a torchlight after dark will result in good hauls of these undesirables. A light sprinkling of crystals of permanganate of potash round a favourite plant is a certain safeguard against slugs.

The autumn overhaul.—When growth dies down in the autumn, cut it off, and where the soil has perished, remove it and replace with good soil. Sprinkle a ½ in. layer of small sharp cinders on the surface of the pockets to keep them dry in winter. If any stones are displaced, replace them, and pull up every weed, as if the roots travel under the stones, nothing short of partial or total dismantling will clear them out.

USEFUL HINTS

Weeding newly sown lawn.—This is rather a delicate operation. If performed in dry weather, the grasses are dragged out along with the weeds. If performed in showery weather, the weeds come up without disturbing the grass. Choose the latter conditions, therefore, or where they are not opportune water thoroughly the day before.

Turfed lawn.—Occasionally the turf used for lawn laying, though good in quality, is matted and shaggy. When it is so, clip it hard back with shears immediately after laying, and in due season healthy young grass will spring up. On no account leave the shaggy mat through winter, otherwise it will collect fog and damp, and bare patches result.

Lawn spiking.—When pushing in the fork tines, and withdrawing them, do not twist or press sideways. Let the entry and exit be perfectly clean and straight, otherwise the roots will be damaged.

Damp lawns.—There are very often damp patches on the surface only, due to continuous mowing and rolling. The condition can be corrected by spreading a thin layer of small, weathered charcoal cinders on the surface, and rolling them in. They quickly become invisible, in no way interfere with mowing, and by opening the soil, allow the water to drain away.

Repairing lawns.—It is obvious that when bald patches appear on a lawn, there must be some fundamental fault. It is advisable therefore, after preparing a place for the new turf, to fork the underlying soil 1 ft.

deep, and mix farmyard manure freely with it.

Slugs in the rockery.—Bran traps quickly rid a rockery of slugs. Spread here and there 4 in. square, 1 in. thick layers of ordinary bran. Cover each layer with a tilted slate. The slugs will flock to the bran, from which they should be removed, and dropped into a pail of brine. Crystals of permanganate of potash are deadly to slugs.

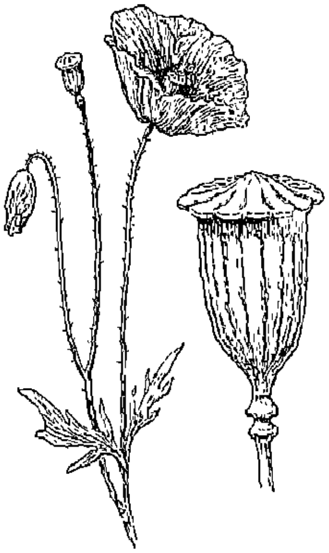


FIG. 157. COMMON WEEDS—THE RED POPPY

The poppy scatters many hundreds of tiny seeds through holes under the cup of the seed-box.

Small rockery shrubs.—No rockery is quite complete if furnished only with succulent plants. A few small shrubs at the summit greatly improve the effect. Shrubs suitable for this purpose are azaleas in variety, Erica mediterranea, Daphne mezereum, Hypericum Moserianum, and any dwarf kind of Cupressus.

Rockery plants for shady places.—It often happens that a shady site can best be developed by forming a rockery in it. The average range of plants is useless in such an aspect but the following will succeed and make a very beautiful picture:—gentians, silenes, aubrietias, houstonias, antennarias, and nepetas.

Winter protection.—Lime-loving rockery plants such as campanulas, creeping gypsophilas and encrusted saxifrages, are liable to damp off in winter unless the crowns are covered with ½ in. layer of small limestone chippings. Specially succulent plants such as the mossy saxifrages, remondias, alpine phloxes and cotyledons are liable to suffer from crown canker unless mulched with 1 in. layer of leaf mould. Both mulches must be applied as soon as the plants are cut down in autumn.

Aggressors in the rockery.—Vigorous growing plants like arabis, iberis, nepeta and the commoner saxifrages quickly overrun the pockets allotted to them. Keep a sharp watch on the trespassers and cut them back promptly, otherwise some far choicer subject growing near may be overwhelmed.

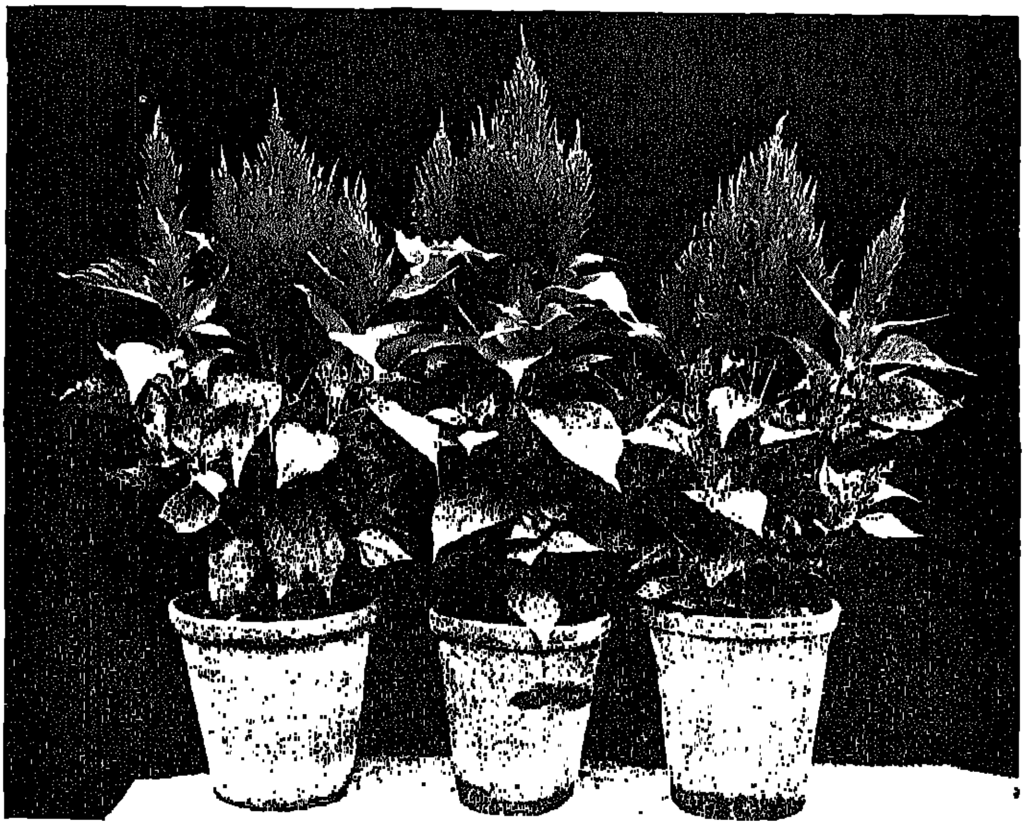
CLASSROOM WORK

Lawn weeds.—Make a list of lawn weeds. Where possible, secure specimens of them, so that they may become familiar to the children. The following are the commonest:—sorrel, creeping buttercup, bulbous buttercup, yarrow, great plantain, ribwort plantain, mouse ear hawkweed, cat's ear, dandelion, pearlwort, daisy, clover, and mouse ear chickweed.

Leatherjacket.—Describe the life history of the leatherjacket, and explain how greatly it injures lawn grasses. The essential points in the life history are egg-laying in August and September, each female depositing 100 to 200 eggs. Larvae hatch in a fortnight, feed until the following July, and pupate for three weeks, when the perfect insect again appears.

THIRD YEAR COURSE

XII. THE STRUCTURE AND MANAGEMENT OF THE GREENHOUSE, AND A SCHEME FOR A YEAR'S SUCCESSION OF CROPS AND FLOWERS



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CELOSIAS

The greenhouse.—The greenhouse is a valuable part of garden equipment. It is indispensable if the garden is to be self-supporting. Without it, much stock, raised elsewhere under glass, must be bought. Included in this category, are summer cauliflowers, summer cabbages, Brussels sprouts, and half hardy bedding plants like snapdragons, stocks, asters, zinnias, and so on. Further, the greenhouse is essential if exotic plants such as chrysanthemums, fuchsias, petunias, palms, dracaenas, etc., are to be grown. Lastly, a glass structure of this kind is valuable for demonstrating the cultivation of tomatoes, cucumbers, French beans, winter lettuce, winter mint, and similar crops.

Types of greenhouse.—There are two types, span roof and lean-to. The latter is not very satisfactory, because light enters on three sides only. A lean-to house is built against a wall or fence. A span roof house, on the other hand, is an independent structure receiving light on both sides and at both ends. It is the type that should be chosen.

Aspect.—As light is one of the vital factors in plant growth, it follows that the situation chosen should be open to the sun all day. The ideal is to run the house north and south; the distribution of light is then even. If at certain seasons shade is necessary, it can be applied artificially.

Size of house.—Nothing is more unsatisfactory than the toy greenhouses sometimes seen. No useful work can be done in them. A house 15 ft. long by 9 ft. wide, and having a maximum height of 8 ft., is eminently suitable for general purposes.

Specification of greenhouse.—Use seasoned deal, 21 oz. horticultural glass, fix dovetail joints, put ventilators at both sides so that air can be admitted no matter from what direction the wind blows, without exposing the plants to the risk of cold draughts. The roof should slope at an angle of 38 degrees, and the wood and glass frames should rest on a 2 ft. high, single brick wall. A good size for the glass panes is 12 in. long by 10 in. wide. Portable stages 3 ft. high should be fitted inside the house, and provision made for a 2 ft. wide path down the middle. At schools where there is a manual instruction class, it may be thought desirable to build the greenhouse. Where there is not, the details given will be helpful when asking for tenders. (See the Woodwork section for Garden Equipment in Volume IV.)

Heating.—A very efficient, and at the moment the most economical method, is a coke-fed boiler fitted with hot water pipes. In districts where electric current can be purchased at slightly less than ¼d. per unit, thermostatically controlled electrical heating is recommended. There is no danger of the fire going out, or of the temperature fluctuating wildly. The thermostat controls that. Where neither boiler nor electricity is available, a fume-proof oil stove may be used. An unheated greenhouse is of little value.

Ventilation.—This is a highly important process, as only by careful study can the temperature be regulated. The ventilators should always be opened on the leeward side, to exclude cold draughts. The extent of the opening depends on the season and on the plants that are being grown. One point that must be stressed is the necessity for opening early enough in the morning to prevent sun scorch. A greenhouse is a sun trap. Unless there is a way out for the rays that pass through the glass, growth will be badly scorched.

Hygiene.—Wash down the greenhouse two or three times each year with hot, soapy water, taking care to get into the crevices. In the latter many insect pests lay their eggs, and diseases find harbour there. Allow no litter to accumulate under the stages, or behind the pipe tracks, otherwise woodlice, cockroaches, and crickets will soon find their way in, breed, and do much damage. Wash the plant pots whenever they become green, or air cannot pass through the porous sides. Wash the glass outside regularly, especially in winter, when dust collects on it, and excludes light.

Watering.—Water should be laid on, and a tank provided of sufficient holding capacity to water everything in the house once. After each watering fill the tank, to allow the water to air to the temperature of the house. Cold water drawn straight from the mains inflicts a serious check. Clean out the tank every six weeks, to get rid of the slime that accumulates at the bottom, contaminating the water. From April 1st to September 30th, water in the afternoon to make sure that no plant passes the night dry. From October 1st to March 31st, water in the morning so that atmospheric moisture can dry up before evening, and prevent damping off. See that each pot or box stands level, and when they need water, fill them to the top. The lighter colour of the soil is generally a sufficient indication of dryness, but where there is doubt, rap the pot twice with an iron nut fixed to the end of a stick. Water if there is a ring in response to the second rap. Pass on if there is a dull thud, as the soil is moist enough, Fig. 158.

Potting shed.—If possible, build a small shed at the end of the greenhouse, and communicating with it. In this shed sow seeds, pot plants, mix composts, store pots and other necessary equipment. Where it is not possible to have a potting shed, much of the work must be done in the greenhouse itself, as it is too risky, especially in early spring, to take greenhouse plants into the open air.

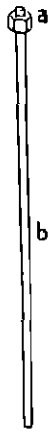


FIG. 158. POT RAPPER
a. Iron nut. *b.* Stick.

Equipment.—This comprises watering cans fitted with roses, a potting bench, dibbers, rammers for firming soil, raffia, stakes, insecticides, fungicides, seed boxes having the following dimensions, length 2 ft., width 1 ft., depth 2½ in., a supply of the following sizes of flowerpots, 2 in., 3 in., 4½ in., 5 in., 6 in., 7 in., 8 in., and 9 in. The measurements refer to inside diameter. All pots must be washed before being used. Further, there must be a supply of the following compost ingredients:—loam or turf, stacked three months before use; leaf mould rotted for six months; peat; well-rotted manure; river sand, and bone meal.

A YEAR'S GREENHOUSE PROGRAMME

Raising vegetable plants.—The following programme can easily be compassed in a 15 ft. by 9 ft. greenhouse.

In February sow Brussels sprouts, summer cabbages, summer cauliflowers, celery, and leeks in boxes, using a riddled compost of loam 3 parts, leaf mould and sand 1 part each.

Later treatment.—When the seedlings are forming their third rough or normal leaf, transplant them 2 in. apart into boxes, adding 1 part of well-rotted manure to the compost advised for seed sowing. Grow the seedlings in the greenhouse until they are well established in these boxes, then harden them off in a cold frame preparatory to planting in the garden.

Raising half hardy summer bedding flowers. In early March sow in boxes lobelia, alyssum, stocks, asters, zinnias, nemesias, salvias, golden feather, ageratum, and snapdragons. Treat the seedlings precisely as advised for the vegetables, finally setting them out in the beds and borders.

Tomatoes.—Sow seed in well-drained 7 in. pots in late January. Space the seed ¼ in. apart. Just cover it with silver sand. Cover the pots first with glass, and then with brown paper. Remove the covers when the seedlings appear.

Treatment of the seedlings.—On the formation of the third normal leaf, plant the seedlings 2 in. apart in boxes. Afford them abundant light. Before overcrowding arises, set the seedlings separately in 2 in. pots. When the roots are ranging freely round the sides of these receptacles, transfer the plants to 4½ in. pots, from which they are repotted into the 9 in. size, in which they fruit.

The final repotting.—Place a layer of inverted crocks or potsherds at the bottom of each pot, next a 2 in. layer of turf broken to walnut size, and on this a 1 in. layer of compost firmly rammed. Set the plant in the middle of the pot, ram the compost firmly round it just covering the soil ball. Thus at first the pots are only about half filled. Make additions of similar compost later, as growth demands. Stand the pots 18 in. apart on the greenhouse stage. An ideal compost is, loam 4 parts, well-rotted manure and sand 1 part each, with a 5 in. potful of bone meal to the barrowful.

Pollination.—When flowers open, dust them daily at noon or thereabouts with a rabbit's tail or camel hair brush to distribute the pollen, and ensure a heavier crop. Experiments prove that pollination increases the yield by 5 to 10 per cent.

The removal of side shoots.—The tomato is naturally a branching plant, but under cultivation is confined to a single stem. Remove, therefore, all side shoots that arise in the leaf joints, with the point of a penknife blade, Fig. 159.

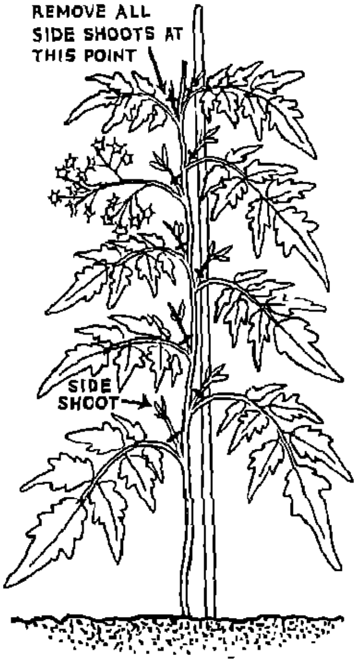

REMOVE ALL SIDE SHOOTS AT THIS POINT
SIDE SHOOT

FIG. 159. TOMATO PLANT SHOWING SIDE SHOOTS

Stopping.—Remove the growing point of each plant one leaf above the fourth truss of fruit. Retain the best of the resulting side shoots, and allow it to fruit. This process prevents the plants from weakening early. When at last they do weaken through sheer exhaustion, again remove the growing point to concentrate nutriment in the developing crop.

Defoliation.—Remove leaves and parts of leaves that by obscuring light interfere with ripening. The process must be very carefully carried out, and limited to the actual needs. Drastic defoliation prevents fruit swelling.

Feeding.—After the first fruits start to colour, feed weekly and alternately with dilute liquid manure and sulphate of potash (one teaspoonful per plant per dose). Sprinkle the fertiliser evenly on the soil, and water it in. Continue feeding until the last fruit is gathered.

Winter lettuce.—Sow seed in boxes as advised for vegetables, and when the seedlings are forming their second normal leaf, transplant them 2 in. apart into other boxes.

Final planting.—Before overcrowding arises in the boxes, transfer the plants to their final quarters. Make upon the stage a 4 in. deep bed of good loamy soil. Place 2 in. of rubble beneath the bed for drainage. Set the plants 9 in. apart, taking care not to bury the tiny growing point.

Watering.—Winter lettuce must be kept consistently moist, but it is essential not to damp the leaves when watering.

Light.—This is a vital need. Unless the crop receives five hours' light per diem, the plants will not heart. See, therefore, that the glass is washed weekly.

Varieties.—Varieties are mentioned here because of their great significance—Cheshunt Early Giant and Loos Tennis Ball are the two sorts which succeed best in winter.

Forcing crops.—Rhubarb.—Forcing crops are crops which, having finished their growth out of doors, are lifted and forced into premature growth in artificial heat. Many can be grown in the greenhouse.

Lift the roots at the end of October, and after exposing them to the elements for a fortnight to retard them, plant them under the stage closely together in ordinary garden

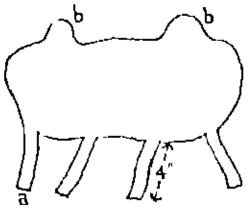


FIG. 160. RHUBARB ROOT PREPARED FOR FORCING
a. Shortened root. b. Crown.

soil. Leave just the crowns or tops exposed. Place a curtain in front of the stage to exclude light, keep the soil consistently moist, and in nine or ten weeks the crop will be ready for gathering, Fig. 160.

Seakale.—Alongside the rhubarb bed make a similar bed of seakale, planting the roots 4 in. apart. Before planting, at any time from the end of October to mid-March, cut off the side roots, bury them in sand, and plant them as root cuttings in boxes in the greenhouse in early February. Cut the seakale when the blanched leaf stalks are 7 in. long.

Chicory.—Can be grown under similar conditions to seakale, with the exception that the side roots must not be removed. Cut the leaf stalks when they are 8 in. long.

Mint.—Lift the roots at any time from early November until mid-February. Shake off the soil, and steep the roots for twenty minutes in water heated to a temperature of 118° F. as a safeguard against rust disease. Plant 1 in. apart and 1 in. deep in boxes, stand the boxes on the stage, and water carefully.

Gathering mint.—When gathering forced mint, cut each sprig just above the third joint from the base, thus ensuring a second growth of side sprigs even more profuse than the first, Fig. 161.

Asparagus.—Three-year-old crowns should be planted in boxes of the margarine type. Use a compost of 2 parts each of loam and leaf mould, with sufficient sand to ensure porosity. Bury the tops of the crowns 3 in. deep, give abundant moisture, and free growth will ensue.

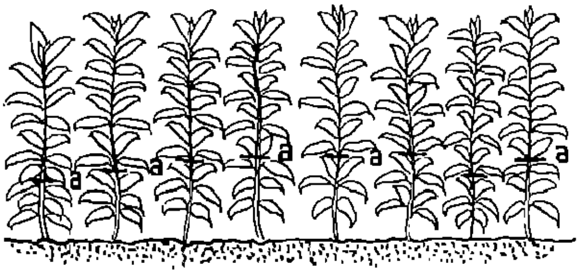


FIG. 161. SHOWING WHERE TO CUT FORCED MINT

a Cut here three joints from the base of the stem.

Greenhouse flowers.—An all-the-year-round succession of flowers should be maintained. This is possible by growing the following:—daffodils, tulips, and hyacinths for blooming in January, February and March; cinerarias for April and May; herbaceous calceolarias for June; pelargoniums, geraniums, and fuchsias for July, August, and September; chrysanthemums for October, November, and December, and Chinese primulas for November to February. Brief cultural details for each of the above subjects now follow:—

Bulbs.—Daffodils, tulips, and hyacinths should be potted in late September or early October. Set daffodils in 6 in. pots, five bulbs equidistant in each; tulips in 5 in. pots, four in each; hyacinths in $4\frac{1}{2}$ in. pots, one in each. Use a compost of loam 3 parts, leaf mould, well-rotted manure, and sand 1 part each.

How to pot bulbs.—Set each bulb on $\frac{1}{2}$ in. layer of sand, to ensure comparative dryness in the vicinity of the root plate. Pack compost firmly round the bulbs, leaving just the crowns or tops exposed. Water thoroughly through a rosed can, Fig. 162.

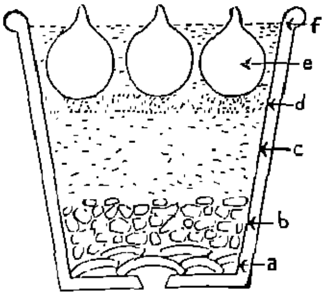


FIG. 162. SHOWING HOW TO POT TULIPS

a. Layer of crocks for drainage.
b. Layer of compost riddlings for drainage.
c. Compost.
d. Layer of sand and planting level.
e. Bulb.
f. Level to which pot should be filled with compost.

The plunge bed.—Bury the pots 4 in. deep in a bed of coconut fibre, sand, or small weathered cinders, leaving them there until the shoots are 1 in. long. Make the plunge bed in a sheltered spot out of doors. The object of the plunge bed treatment is to stimulate the bulbs to form roots before developing shoots. Unless they do this, the buds will go blind.

Later treatment.—On removing the pots from the plunge bed, stand them in a partially shaded cold frame for a week, to enable the pale yellow shoots to turn green slowly. Violent exposure to light is another cause of bud blindness. The week over, transfer the bulbs to the greenhouse, where with careful watering they will unfold perfect flowers.

Cinerarias.—Sow the large-flowered and the stellata varieties in boxes in the cold frame in early July. When the seedlings are large enough to handle, transfer them separately into 2 in. pots. Shade the glass lightly with whitewash.

Later treatment.—When the roots range freely round the sides of the 2 in. pots, repot into the 4½ in. size. At the end of September, remove the plants to the greenhouse.

Winter management.—Afford abundant light, remove basal yellowing leaves, and if green fly attacks, as it very likely will, destroy it by spraying with nicotine insecticide. In early February transfer the plants into 7 in. pots, the flowering size. Use a compost of loam 3 parts, well-rotted manure, nut charcoal, and sand 1 part each. Pot firmly.

Feeding.—After the roots reach the sides of the final pots, feed weekly with dilute soot water until the end of the flowering season, during which the glass over the plants should be heavily shaded.

Herbaceous calceolarias.—Can be grown under generally similar conditions to those advised for cinerarias. The differences are that the seed, being exceptionally tiny, must be mixed with an equal quantity of white flour, to ensure even distribution. And when the plants are 4 to 5 in. tall, the growing point must be removed, to promote a branching habit.

Pelargoniums and geraniums.—In the first instance stock must be bought, as raising plants from seed is not practicable. Nurserymen supply young plants in 2 in. pots. They quickly need potting into the 4½ in. size, in which they bloom the first season. Remove the growing point at 5 in. tall, to ensure side shoots.

After flowering.—When the plants finish flowering, gradually withhold water, and as soon as the leaves yellow, lay the plants on their sides for two or three weeks. Then shorten each shoot two-thirds of the way back, water moderately for a time, and before winter many young growths will develop, Fig. 163.

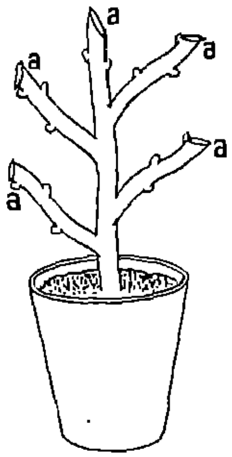


FIG. 163. PELARGONIUM CUT BACK AFTER FLOWERING

a. Shoots cut two-thirds of the way back.

Spring treatment.—In early March repot the plants into 6 in. pots, making the soil very firm. Afford abundant light. When buds show, commence feeding with dilute liquid manure, and continue at weekly intervals until the end of the flowering period. Then dry off the plants, cut them back as advised above, grow them a third year in 7 in. pots, afterwards rejecting them.

Propagation.—This is effected by means of cuttings inserted in July in boxes of sandy soil deep enough to allow for a glass covering during the rooting period. Turn the glasses daily to avoid an over-humid atmosphere. When young growth forms, plant the cuttings (which will then have formed roots) separately in 2 in. pots, winter them on a light stage, and in February take up the culture as outlined for bought-in plants. Ideal cuttings are 2½ in. long, unflowered shoots. Prepare each for insertion by removing the leaves from the bottom inch of stem, and shaving the latter across immediately beneath the joint.

Fuchsias. Stock must be bought in, as seed sowing is slow and unsatisfactory. Essentially, cultural treatment is similar to that suggested for geraniums and pelargoniums. Differences arise in the following respects. After flowering, the plants are gradually dried off, and during winter the dormant plants are laid on their sides in a dry, frost-proof place. In early February return the plants to the greenhouse, and when growth is just starting, cut each shoot two-thirds of the way back. When the side shoots are 2 in. long, take as many cuttings as are necessary to increase or perpetuate stock.

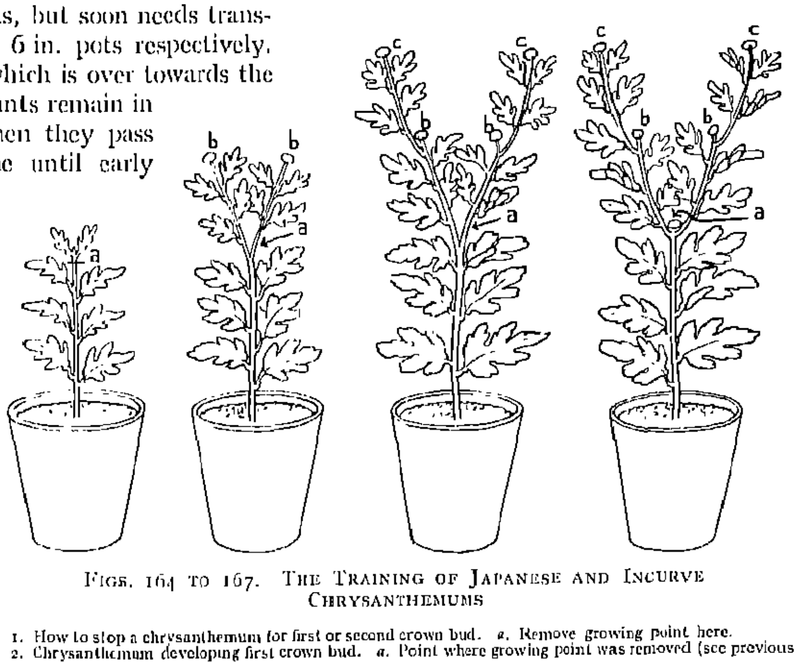
Chrysanthemums.—In the first instance stock must be bought in February. It is supplied in 2 in. pots, but soon needs transferring into 4½ and 6 in. pots respectively. During this stage, which is over towards the end of April, the plants remain in the greenhouse. Then they pass into the cold frame until early June.

The final potting.—About mid-June transfer the plants into clean, well drained, half filled 8 in. pots in a rich loamy compost, and stand them out of doors in a sunny spot until late September, when they are staged in the greenhouse for flowering.

Conditions during the flowering period.—Maintain a dry airy atmosphere, and a temperature of 50° to 55° F. Water very cautiously, leaning to the dry side.

Classification.—There are four sections of greenhouse chrysanthemums, namely, Japanese, Incurve, Decorative, and Single. The two first named sections are grown on the disbudding principle, no more than one bloom being allowed to develop on each shoot. Each plant may have one, two or three shoots, according to the size of bloom desired. Decorative and Single varieties are grown on the natural or spray principle. Only those buds are removed which are obviously too weak to form a good flower.

Training Japanese and Incurve chrysanthemums.—There are innumerable varieties, which are stopped at various times from mid-March until mid-May. A good nurseryman's list gives the stopping dates. Sometimes the variety concerned continues growing until it forms its buds in August. Such varieties as this are said to flower on the first crown bud. Other varieties form buds



FIGS. 164 TO 167. THE TRAINING OF JAPANESE AND INCURVE CHRYSANTHEMUMS

1. How to stop a chrysanthemum for first or second crown bud. *a*. Remove growing point here.
2. Chrysanthemum developing first crown bud. *a*. Point where growing point was removed (see previous drawing). *b*. First crown bud.
3. Chrysanthemum developing second crown bud. *a*. Place where growing point was removed (see first drawing). *b*. First crown bud, to be removed as soon as it appears. *c*. Second crown bud.
4. Chrysanthemum developing natural break. *a*. Natural break. Bud to be removed as soon as it appears. *b*. First crown bud. *c*. Second crown bud.

in May. These are removed, and one of the resulting side shoots is retained. Buds are formed in August. A third section of varieties is not stopped at all, but is allowed to make a natural break. The buds that appear in August may be first or second crown. By following this apparently rather complicated but actually simple method, all the flowers and buds appear at the same time, Figs. 164 to 167.

Side shoot removal and disbudding.—The first step is immediately after stopping, or when the side shoots form after the natural break, as the case may be. One, two, or three are retained on each plant. Throughout the season these shoots will develop side shoots. Remove them with the point of a penknife blade. In August, when the buds appear, remove all but the central one on each stem.

Training Decorative and Single chrysanthemums.—Remove the growing point of each plant at 5 in. tall, and also remove the growing point of the resulting side shoots at the end of June. Allow every healthy growth and bud to develop.

Propagation.—This is by means of cuttings which are inserted from early December to the end of February. Choose 2 in. long basal shoots or suckers. Plant them 2 in. apart in boxes of sandy soil. Cover the boxes with glass until the cuttings are rooted, then set them separately in 2 in. pots, and follow the programme already advised.

Chinese primulas.—Sow the seed in early February in clean, well drained seed pans or 7 in. pots. Just cover it with silver sand. Before sowing soak the seed overnight in clear water to expedite germination.

Later treatment.—When the seedlings are large enough to handle, transplant them 1 in. apart into boxes, and as they need it into 2 in., 4½ in. and 6 in. pots respectively. Use a peaty compost, and handle the plants carefully, as growth is very brittle.

The summer programme.—From early June until the end of September, grow the plants in a shady, cold frame, plunging the pots to the rim in small, moist cinders. After the roots reach the sides of the pots, feed weekly with dilute soot water until flowering finishes.

The autumn and winter programme.—On housing the plants in late September, afford abundant light. Place a cordon of charcoal around the main stem as a safeguard against soft rot, and after flowering starts, remove the individual faded flowers regularly, or bud production will soon cease.

USEFUL HINTS

Propagating frame.—In every greenhouse there should be a propagating frame in which to germinate seed and strike cuttings. The following are useful dimensions:—length 3 ft.; width 2 ft.; depth at front 1 ft.; depth at back 1 ft. 4 in. The frame should be fitted with one light, and should stand on a draught-free stage. Half fill it with coconut fibre in which to plunge pots and boxes. This fibre is very retentive of moisture and heat.

Fume-proof oil stove.—If a fume-proof oil stove is used for heating, it should be cleaned regularly, otherwise objectionable and destructive fumes will be generated in the greenhouse. The feet of the stove should stand in a water bath, which absorbs any chance fumes that may be generated in the event of a temporary fault in the apparatus.

Hardening off.—When plants are transferred from the greenhouse to the cold frame, their initiation to the changed conditions must be very gradual. Thus it is advisable to keep the frame entirely closed for three or four days, after which a little ventilation may be applied, increasing the amount later.

Repotting.—Always water a plant the day before repotting, whether the soil appears dry or not, to reduce to a minimum the risk of root damage. When a plant growing in dry soil is removed from a flowerpot, the roots are badly torn, and a serious check ensues, Fig. 168.

Stand flowerpots level.—This is a very important, though often neglected precaution. Unless all the pots in the greenhouse do stand level, it is obviously impossible to water them efficiently.

Gathering rhubarb.—When gathering forced rhubarb, grip each stem firmly towards the base, and twist and pull simultaneously. Then the stem concerned will leave the crown cleanly, and there will be a perfect heal. A stub is left behind after the sole pull, and it often causes crown rot.

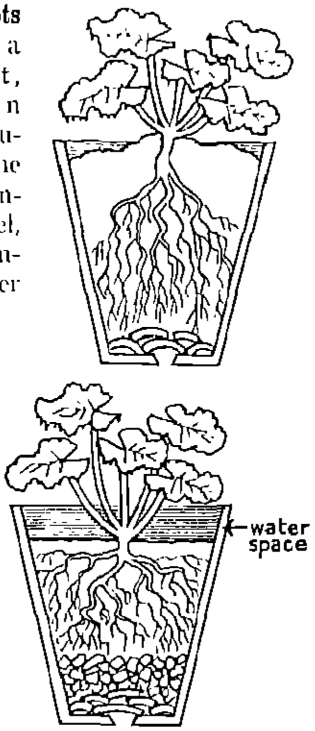


FIG. 168. HOW TO POT A PLANT

In the top diagram the pot has been filled too full with soil, leaving little room for water.

In the lower diagram there is plenty of room for water.

General potting compost.—The following is an ideal compost for general potting purposes:—loam 3 parts, leaf mould, well-rotted manure, and sand 1 part. To give the compost an even texture, pass the ingredients through a ¾ in. riddle. Always warm the compost in a box on the pipes three or four days before using it.

CLASSROOM WORK

Flowerpots.—Flowerpots are sold by the cast, a technical term used to indicate a certain number of pots. The following list shows the number of pots in a cast of the various sizes:—2 in. 72; 3 in. 60; 4½ in 48; 5 in. 40; 6 in. 32; 7 in. 28; 8 in. 16; 9 in. 12.

Ordering seeds.—When the seed order is being prepared in spring, a decision should be taken as to the number of each kind of plant to be grown. Let the children then calculate the number of pots of each size required, so that an appropriate order can be sent. In the absence of a system of this kind, *pots of unwanted sizes will accumulate*, and there will be a shortage of those sizes that are most in demand.

Sort tomato seeds.—In every packet of tomatoes there are seeds of various sizes. Separate them into two rough grades, the large and the small. Label the plants from both grades, and note which give the heavier yield. In most cases it will be found that the honours go to the large seed.

Prepare seakale thongs.—When seakale plants are being prepared for forcing, cut off the side roots in the classroom. Divide them into pieces 3 in. in length. Make a small nick at the top of each piece, so that when these thongs are planted as root cuttings, they can be set in the correct position. Until planting time in early February, store the thongs in boxes of sand in a frost-proof place.

Bulb plunge bed materials.—Submit fibre, sand, and small cinders to a critical examination. Point out that fibre is clean and retentive of moisture. Sand is clean but not so retentive. Cinders are neither very clean nor retentive of moisture, hence fibre is the best, though when this is unobtainable, the other two give very good results.

Daffodil bulb.—Before potting bulbs, cut open longitudinally a good-sized daffodil bulb. Point out the scales and the embryo bud in the centre. Make it clear that the utmost care must be taken in handling and in growing,

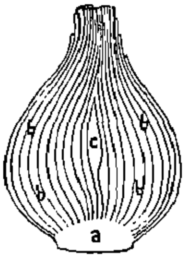


FIG. 169. DAFFODIL BULB

a. Root plate.
b. Bulb scales.
c. Embryo flower bud.

otherwise, this delicate structure will be badly damaged, Fig. 169.

Dressing chrysanthemum blooms.—With a pair of floral tweezers adjust the position of chrysanthemum petals so as to give a perfectly symmetrical bloom. This enhances the beauty of the chrysanthemum display, and introduces the children to the principle of flower dressing.

XIV. USES AND MANAGEMENT OF THE COLD FRAME AND CLOCHES

The cold frame.—A cold frame is valuable as an adjunct to the greenhouse. Before vegetables and flowering plants raised in heat can be put out into the open garden, they must be "hardened off" or gradually acclimatised to outdoor conditions. A cold frame provides an ideal medium for this process. It can also be used for the raising of semi-hardy bedding plant cuttings, such as violas, calceolarias, pentstemons, snapdragons, and marguerites. Hardening off and the raising of cuttings fill the frames from September to May. From May to September the frame can be profitably occupied by ridge cucumbers and even tomatoes. Thus at no season is the structure idle.

Types of cold frame.—There are several, but the only two that need be mentioned are the type possessing brick sides, and the one having wood sides. The former is slightly warmer in winter, but has the disadvantage of being a fixture. A frame having wood sides can be moved at will. For general purposes the latter is preferable.

Dimensions of frame.—30 in. is a convenient height at the back, 26 in. at the front. This allows a sufficient gradient for the gathering of natural heat and for conducting rainwater away quickly. 5 ft. is a convenient distance between back and front. 3 ft. to 4 ft. is a convenient width of light, or movable glass covering. It is very important not to make the lights too unwieldy, or they are continually being broken. Between each two lights a runner should be fixed, and each frame should not have more than two lights. Where one two-light frame is not equal to the demand, two should be made. By working in small units like this, it is possible to give the plants that differential treatment which is such a help to them.

Best position for the cold frame.—The cold frame should stand on a 1 in. deep bed of small cinders in a sunny, sheltered spot. Exposure to cold north and east winds is fatal to the progress of plants, especially in spring, when these winds are more prevalent.

Ventilation.—Graduated blocks of wood should be made to enable the lights to be lifted to various heights in accordance with the weather. Always fix the blocks on the leeward side to exclude cold draughts. Generally, air should be admitted at all seasons when the weather is favourable, as the atmosphere in frames tends to become clammy, Fig. 170.

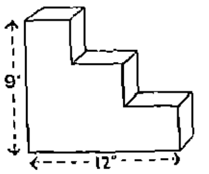


FIG. 170.
WOOD BLOCK FOR VENTILATING COLD FRAME

Cold frame cultures.—The preparation of stem cuttings was dealt with on page 43. The process need not be described again, but the actual treatment of the cuttings must be mentioned.

Stem cuttings after insertion.—Violas, calceolarias, pentstemons, and marguerites are all propagated by stem cuttings inserted in early October. Immediately after insertion, water thoroughly, and keep the lights closed until the appearance of young growth denotes rooting. Then ventilate as freely as the weather permits. During frosty periods, cover calceolarias, pentstemons, and marguerites with mats; violas need no protection beyond that afforded by the lights.

Spring treatment.—Towards the end of April, ventilate much more freely, and in early May remove the lights altogether on favourable days. Towards the end of the month set the plants in their flowering quarters.

Cucumbers.—Sow in late March in the greenhouse. Set the seed separately, ¼ in. to ½ in. deep in 3 in. pots. During the early stages shade the plants lightly, and when watering, avoid stem splashing, or canker disease will break out.

Preparation of the hotbed.—Even in cold frames cucumbers must be helped by the heat from a hotbed of fermenting manure. Start to prepare this in early May. Use equal parts of fallen tree leaves and strawy horse manure containing 20 to 30 per cent of droppings. Mix the ingredients thoroughly, and turn them over on alternate days for a fortnight. During this period the temperature will ascend, and begin to decline. When it falls to 75° F., transfer the manure to the cold frame, depositing there a firm layer, 1 ft. deep.

Preparations for planting.—Cover the manure with ½ in. layer of ordinary garden soil to absorb ammonia fumes without preventing the heat from passing through. At the centre of each light form a 9 in. wide, 6 in. high, mound-shaped heap of a compost of loam 4 parts, well-rotted manure and sand 1 part each. Three or four days later, when the compost has warmed through, plant one cucumber in each mound, Fig. 171.

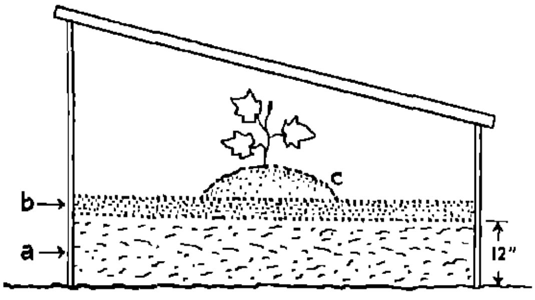


FIG. 171. CUCUMBER PLANTED IN COLD FRAME

a. Hotbed.
b. ½-in. layer of garden soil.
c. Mound of compost.

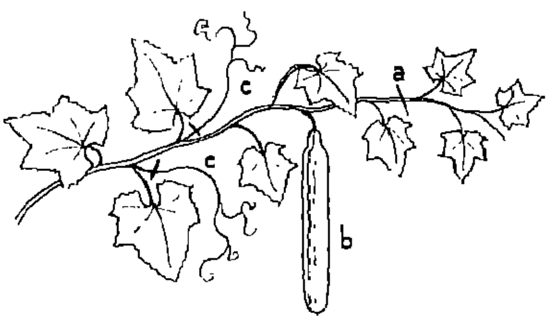


FIG. 172. SHOWING HOW TO STOP A CUCUMBER PLANT

a. Remove shoot at this point, one leaf beyond cucumber.
b. Cucumber.
c. Tendril. Remove at this point.

Syringing and shading.—On bright days, syringe morning and afternoon with clear, aired water. Apply slight shade to the glass to prevent sun scorch.

Watering and top dressing.—Cucumbers need abundant water, which must be aired. Every time white roots appear through the mound, top dress with a 2 in. layer of a compost similar to that advised for planting.

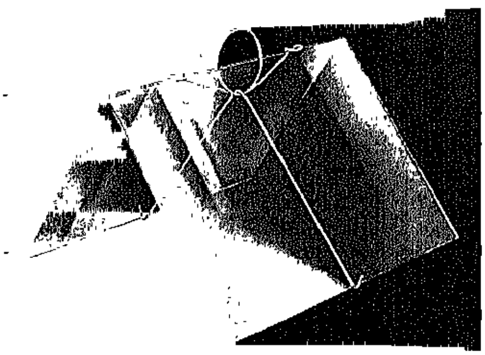
Training.—When the plants are forming their seventh or eighth leaf, remove the growing point, to induce a branching habit. Soon the side shoots will develop cucumbers. As these begin to swell freely, remove the bearing shoot one leaf beyond the fruit. Follow the same method with the resulting side shoots, and plants of the maximum fertility will gradually be built up, Fig. 172.

Feeding.—Feed weekly with quarter strength liquid manure after the first fruits are 2 in. long, until the end of the season. At all costs avoid phosphatic fertilisers, as these promote seed development, which in cucumbers is undesirable.

Hardening off in cold frames.—When plants of any kind are transferred from the greenhouse to the cold frame for hardening off, keep the lights closed for three days, then open them an inch or two for the next three days. Afterwards generous ventilation may be given if the weather is favourable.

Cloches and their uses.—Cloches are small portable glass covers which are used for advancing the growth of early vegetables, flowers and fruit. They are a modification of the bell glasses used so extensively on the Continent. In recent years British gardeners have employed cloches in ever-increasing numbers. They are likely soon to form an integral part of horticultural practice.

Types of cloches.—There are two types in general use, namely, tent and barn. The former are composed of sheets of glass fixed at an angle of about 45°. The latter are formed of two sheets of glass fixed at a similar angle. They have sides also. In each case the glass is held in position by easily adjusted wires. The size of cloches varies in accordance with the plants to be grown underneath. The height may be as low as 3½ in. for radishes and lettuce. It may be as much as 18 in. for taller subjects such as cauliflowers and strawberries. Cloches are fitted end to end, thus giving complete cover.



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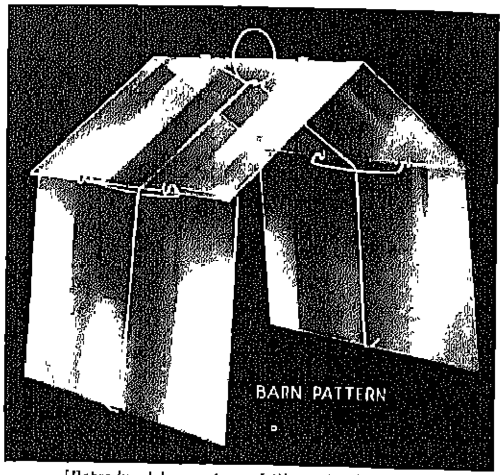
CHASE CONTINUOUS CLOCHE—" TENT " PATTERN



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CHASE CONTINUOUS CLOCHE—" BARN " PATTERN

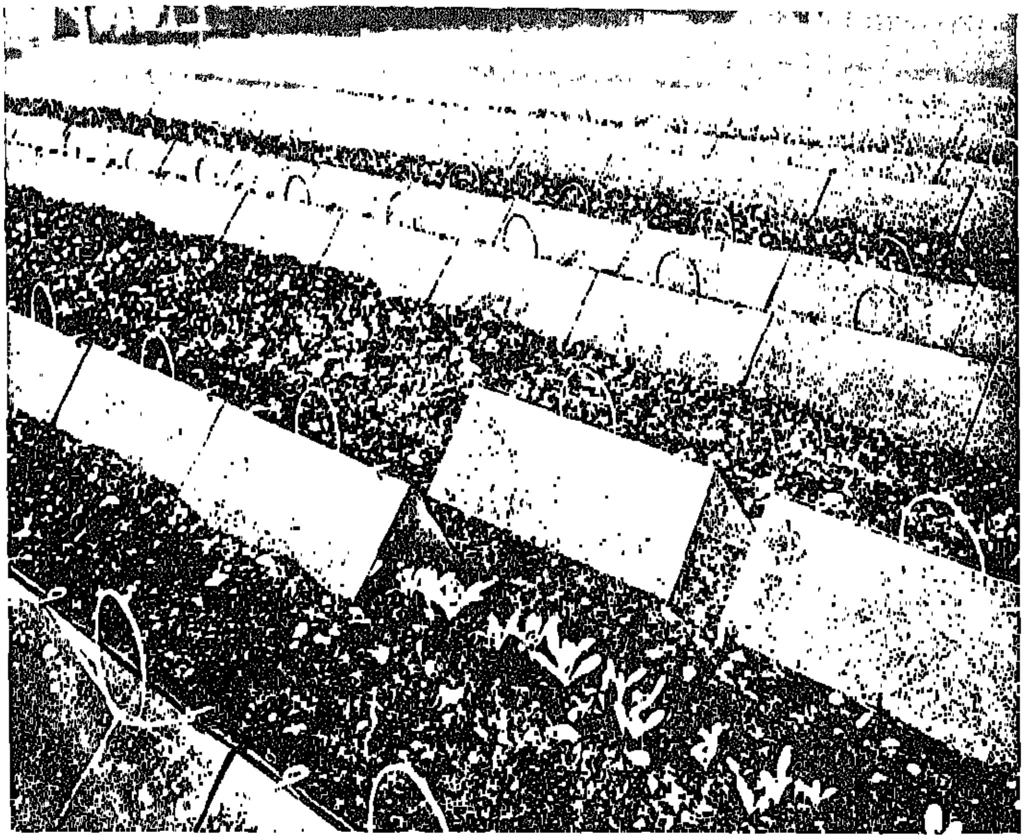
The cultivation of plants under cloches.—It is proposed to give an example of one vegetable, one flower, and one fruit that can be grown under cloches, to illustrate the principles.

Peas.—Sow the seed in early January in soil dug 1 ft. deep, and lightly dressed with well-rotted stable manure and bone meal. The 18 in. high cloche is needed for this crop. Space four rows of seed 3 in. apart and 3 in. deep down the centre. Put the cloches over immediately after sowing. Do not remove them unless it is absolutely necessary. Natural heat is garnered beneath the cloches, and must not be allowed to escape.

Watering.—When watering is necessary, apply the water at the outside of the cloches, and allow it to work its way underneath by capillarity and surface tension.

Ventilation.—Cloches are so constructed that sufficient air enters without any glass adjustment.

Weeding and soil stirring.—If weeds grow along with the crop, they must be pulled up on a warm, favourable day, and the cloche replaced quickly. Should the soil cake, stir it with a hand fork. It is not often, however, that it does. For some reason, not quite



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CHASE CONTINUOUS CLOCHE—SIZE "S" (SEED RAISER)

This Cloche is invaluable for raising seedlings

understood, soil texture is well maintained beneath these glass structures.

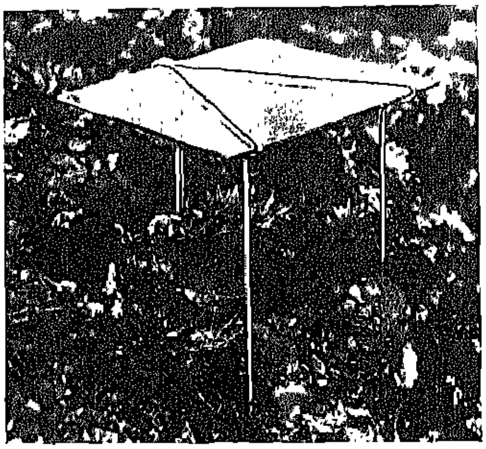
Feeding.—As soon as the first flowers fall, stir in a 1 oz. per yard run dressing of superphosphate of lime, to help the pods to fill.

Ten week stocks.—In early February, sow under 9 in. high cloches, a batch of ten week stocks. The only soil preparation needed is light forking. Cover the seed by raking.

Later treatment.—When the seedlings are large enough to handle, transplant them 3 in. apart under similar cloches, in well-manured soil. Weed, water, and attend to soil stirring in the manner suggested for peas. In early May remove the cloches, and in Mid-May transfer the stocks to their flowering quarters.

Strawberries.—At the end of March lightly fork the soil round strawberries, working in a 1 oz. per yard run dressing of sulphate of potash. Cover the plants with 18 in. high cloches, water whenever the soil is dry, and perfect fruit will ripen two or three weeks before the uncovered crop.

Subjects suitable for cloche culture.—*Vegetables and salads*—lettuce, radishes, mustard and cress, shorthorn carrots, six weeks turnips, peas, broad beans, French beans, runner beans, early potatoes, celery, leeks, vegetable marrows, and ridge cucumbers



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CHASE CONTINUOUS CLOCHE—ALPINE PROTECTION NO. 1

Flowers—stocks, asters, zinnias, nemesias, antirrhinums, verbena, salvias, lobelia, ageratum, and alyssum.

Fruit—strawberries and tomatoes. In some of the above cases, such as that of runner beans, the cloche protection is given only during the first few weeks. As soon as the plants need more head room, the cloches are removed.

USEFUL HINTS

Cold frame with wood sides.—Where, for reasons of expense or any other consideration, a frame with wood sides must be built, it can be kept frost-proof during severe periods by surrounding the sides with litter. This precaution is very advisable, as if the soil is frozen, the plants concerned will almost certainly perish.

Shade newly inserted cuttings.—If immediately after inserting cuttings in frames the sun shines brightly, throw a mat or sacking over the glass during the critical period, otherwise the cuttings may droop beyond recovery. Watch carefully, and cease shading as soon as it is obvious that growth can maintain turgidity unaided.

Earthworms in cutting frames.—Though every precaution should be taken to exclude earthworms, these creatures do sometimes invade cutting beds, foul the surface with their unsightly casts, and displace the cuttings. When this happens, remove the casts, replant the cuttings, and stir into the bed a light dressing of weathered soot, which will drive the earthworms to lower levels.

Protect cucumber stems.—Even after every watering precaution is taken, moisture does sometimes lodge on the main stems of cucumbers, setting up canker or dry rot disease. To prevent this, surround each stem at the soil level with pieces of lump charcoal or lime rubble about the size of a small walnut.

Cutting cucumbers.—Cucumber yields are often reduced by allowing mature fruits to hang on the plants too long, thus absorbing food that should go to the younger cucumbers. The correct stage at which to cut is just before the skin starts to harden. When the thumb nail will not go through the skin, the fruit is past the correct cutting stage.

Washing cloches.—Light is an essential factor in the cultivation of plants under cloches. As these glass structures are used at a season when atmospheric impurities are abundant, it is advisable to wash them regularly.

Strawberry runners.—All runners must be removed from strawberries growing under cloches, to ensure the maximum yield of early fruit.

CLASSROOM WORK

Viola stipules.—Violas are provided with very large stipules, growths which occur at the base of the leaf stalks. Unless these are carefully removed before the cuttings are planted, they may and often do cause damping off. They might well be removed in the classroom, the significance of the process being explained.

Cucumber tendrils.—Cucumbers in frames need no tendrils to support them, hence these growths are redundant. Show a typical tendril-bearing shoot to the children, clip off the tendril with sharp scissors, explaining that now the tendril is removed, the cucumbers themselves will get more food, and will, therefore, do better.

Bull-necked cucumbers.—This is the term applied to cucumbers which are unduly swollen at the stem end. The flowers were pollinated. Thus the plant is devoting its energy to the production of seeds, which in ordinary culinary cucumbers are not needed. Cut open the fruit, and show the mass of developing seeds. Explain that such cucumbers should be promptly removed, Fig. 173.

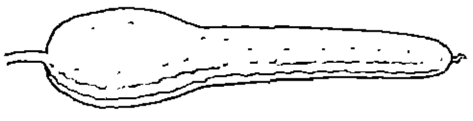


FIG. 173. BULL-NECKED CUCUMBER, THE RESULT OF POLLINATION

Protect peas from mice.—Before sowing peas under cloches, steep the seed in paraffin for five minutes, afterwards rolling it in red lead as a safeguard against attack by mice, which in the early part of the year are on the look out for any tit-bit that is going.

Records of growth.—As cloche cultures are to some extent on their trial, it is advisable to make careful records of growth. If possible make sowings of the various plants simultaneously out of doors, and compare the rate of progress. A well-prepared record of this kind will prove invaluable.

Mice under cloches.—Mice are often very troublesome under cloches, and their depredations pass unnoticed until it is too late. Keep a sharp look out for them, and set temptingly baited traps immediately an invasion is noticed. Where mice are known to be numerous an excellent plan is to sprinkle a little naphthalene around the cloches immediately after sowing. These rodents will not burrow anywhere near this chemical.

Transplanting stocks.—Immediately before transplanting stocks under cloches, snip ¼ in. from the base of the tap root. This expedient is adopted by many nurserymen and leading growers for the purpose of increasing the proportion of double flowers. Undoubtedly the check administered achieves this end, Fig. 174.

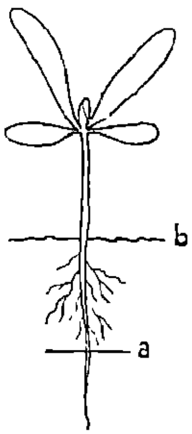


FIG. 174. STOCK SEEDLING

a. Shorten tap root at this point, to induce doubling of the flowers.
b. Soil level.

Make strawberry mats.—As soon as strawberries under cloches have set their fruit, the latter should be protected from soil splashing by a layer of straw. Simple straw mats might be made for this purpose. All that is needed is a light framework of wire or bamboo tips, to which the straw is tied—a very suitable job for the girls, Fig. 175.

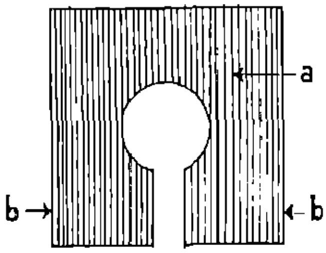


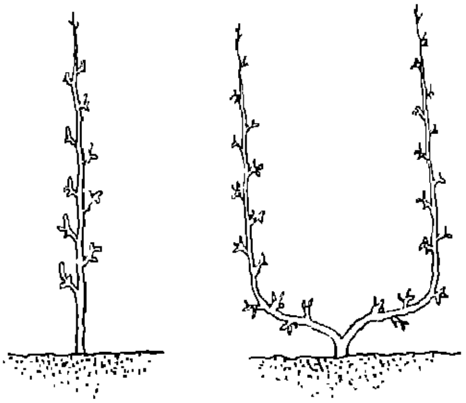
FIG. 175. STRAW MAT FOR PROTECTING STRAWBERRY FRUIT

a. Straw.
b. Wire or bamboo frame-work.

Potatoes under cloches.—The potato (*Solanum tuberosum*) is of sub-tropical origin. It is, therefore, more at home under cloches than in the open, and in consequence flowers very profusely. As flowers reduce crop yields, they must be removed in the bud stage. Choose the time carefully—some calm, sunny day. Success in cloche gardening depends on enlisting the aid of the elements.

XV. FRUIT CULTIVATION

Of all branches of gardening, fruit cultivation is generally the most neglected. Possibly this is due to the fact that for many years reliance was placed on imported supplies. The imposition of tariffs and quotas in 1931 completely altered the outlook. Since that year thousands of acres of fruit have been planted, and an effort is being made to modernise methods of culture. In this effort teachers should play their part. The methods here given represent the latest.



Figs. 176 and 177. Types of Tall Fruit Trees

The left-hand drawing shows a single cordon type of tree, while the right-hand drawing shows a double cordon type of tree.

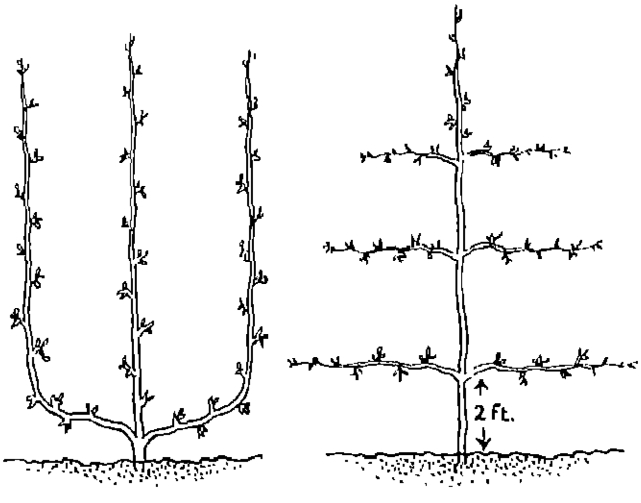
Apples.—Apples are the most important of our tall fruits. They succeed well in all parts of the country, though the best crops are gathered in the eastern half, where the average annual rainfall is lower.

Types of tree.—The most important are bush, half standard, standard, cordon and espalier. The diagrams depict the characteristics of these types, Figs. 176–182.

Bush trees.—Bush trees have a 2 ft. to 2½ ft. tall main stem, from the top of which the branches diverge. The average number of main branches on each tree is twelve. Bush trees are budded or grafted on to paradise stocks, which induce a surface fibrous rooting habit, early fruit-bearing, and a branch system of moderate spread. 10 to 12 ft. is the average spread, hence a bush tree is as broad as it is tall. On account of its moderate demands on space, and early fruiting habit, it is the most popular type.

Half standard trees.—Half standard trees have a main stem 3½ to 4½ ft. tall. They are budded or grafted on to crab stocks, which postpone the economic bearing period seven or eight years. The life, however, is longer than that of the bush type. Half standards are mostly planted in grass.

Standard trees.—Standard trees have a main stem 4½ to 6 ft. tall with a wide spread-



Figs. 178 and 179. Types of Tall Fruit Trees

The left-hand drawing shows a triple cordon tree, while the right-hand drawing illustrates an espalier type of tree.

ing head at the top. They are the true orchard trees, often having a branch spread of 30 ft. Like half standards, they are budded or grafted on to crab stocks, and a dozen years may elapse before the trees come into profitable bearing. Comparatively few trees of this type are planted now.

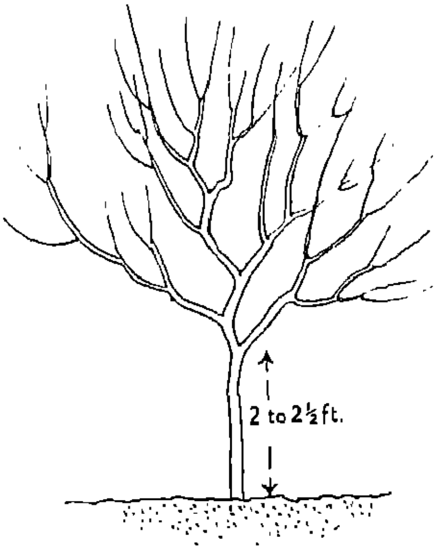


FIG. 180. BUSH APPLE TREE

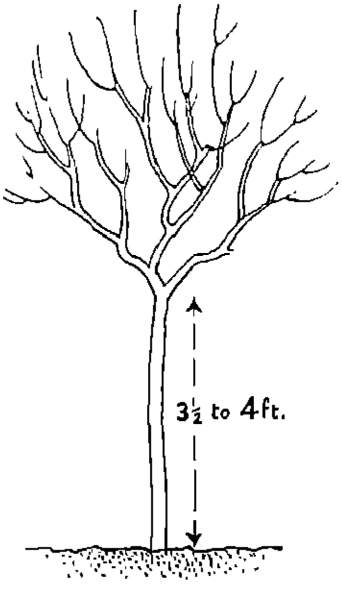


FIG. 181. HALF STANDARD APPLE TREE

Cordon trees.—There are three types, *Single*, having one branch, *Double*, two branches, and *Triple*, three branches. These trees are valuable for planting alongside walls and fences. On them the finest fruit is produced, because air and sun have full play on the branches. They are budded or grafted on to paradise stocks, hence fruit bearing is early.

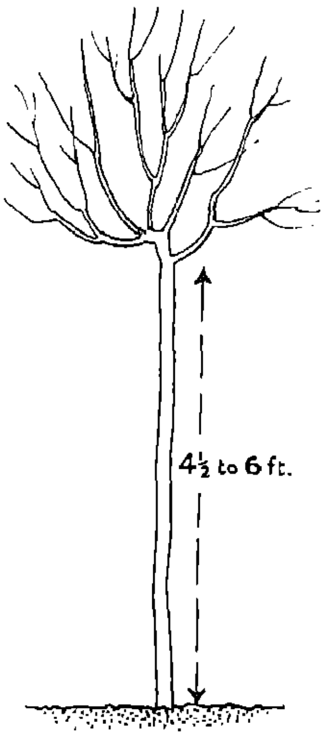


FIG. 182. STANDARD APPLE TREE

Espalier trees.—A special form of tree designed for planting alongside paths. Tiers of branches spread on each side of the main stem, and are trained to wires. Espaliers are budded or grafted on to paradise stocks, which induce the early fruit-bearing habit. This is a fine type of tree where there is accommodation for it.

Aspect.—Apples succeed best in a south, slightly south-west or slightly south-east aspect. North is hopeless on account of the absence of sun. East exposes the blossom to serious frost damage, while the west is open to high winds which may result in serious branch breakage.

Drainage.—Free drainage is very important. If surplus water is held up, the trees are very liable to canker disease. Where there is any doubt, a system of land tile drainage should precede planting.

Shelter.—If the situation is exposed, some shelter should be provided on the windward side. An economic method is to plant half standard damsons at 15 ft. apart. A hedge of Myrobalan Plum or the evergreen Cupressus Lawsoniana is also effective.

Soil preparation.—Apples do not in the early stages make the most successful growth in rich soil. They become too exuberant. If the land is in decent heart, add no stable manure, but work in a 3 oz. per square yard dressing of bone meal. Dig a foot deep, and break up the lumps finely. Commercial fruit growers like to plant after wheat or vegetables, because the land is then in such excellent physical condition.

Planting period.—This extends from late October until the end of March. Autumn is better, because the trees are given an opportunity to become established before winter. Operations must be suspended during frosty periods and when the land is too wet to work kindly.

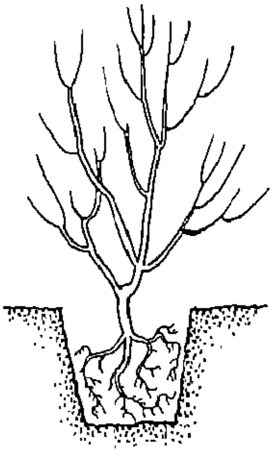


FIG. 183. INCORRECT WAY OF PLANTING FRUIT TREES

The hole is too small and thus the roots are cramped.

Age of tree.—Plant three-year-old bush, cordon, and espalier trees. Half standards and standards should be five or six years old.

Planting method.—Form a hole wide enough to receive the outspread roots comfortably, and deep enough to bury the stem at the soil ring. This is a dark ring 3 or 4 in. above the top roots. It indicates the depth of the previous planting, and is, therefore, a safe guide. Fill in the hole carefully and firmly with fine soil, Figs. 183 and 184.

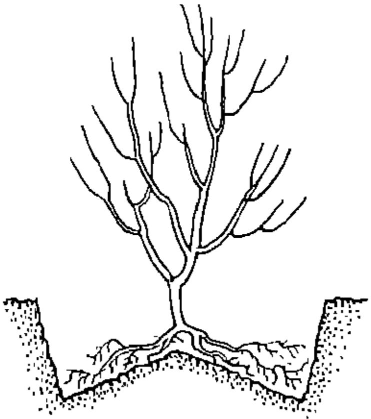


FIG. 184. CORRECT WAY OF PLANTING FRUIT TREES

The hole is large enough to allow the roots to spread out to their full length.

Staking.—Bush trees need no staking. Half standards and standards do. The stake should finish where the branch head begins. Before tying the tree, wrap round the trunk a strip of cloth to prevent bark chafing.

Pruning bush trees.—Do no pruning for twelve months. Immediately after leaf fall, shorten the main branches two-thirds of the way back, and the laterals to within two buds or eyes from their base. A year later, shorten the current year's main branches half way back, the side shoots as above described. Follow a similar course the third year. This method ensures the formation of main branches well served with laterals, and capable of bearing fruit from one end to the other. Subsequent pruning is that accorded to a mature tree. It consists of shortening the laterals each July to within five or six good leaves from their base, and after leaf fall, of shortening still further to within two eyes from the base. The laterals thus treated are known as artificial spurs. The process of forming them induces natural spurs to develop also, Figs. 185, 186 and 187.

The leading shoot.—At the end of each main branch is a shoot similar in structure to that of a lateral. It is known as the leader, and by virtue of its position, provides for extension. Do not shorten it in summer, and in winter remove only the unripened tip.

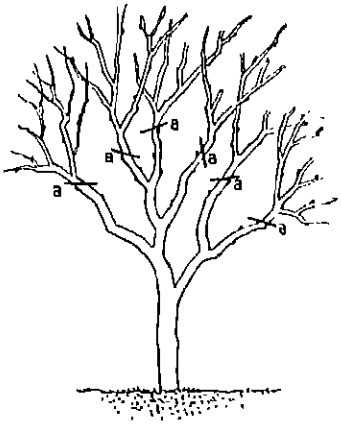


FIG. 185. SHOWING HOW TO PRUNE BUSH APPLE TREE TWELVE MONTHS AFTER PLANTING

a. Cut branches to this point, two-thirds of the way back, every cut to be made to an outward pointing eye.

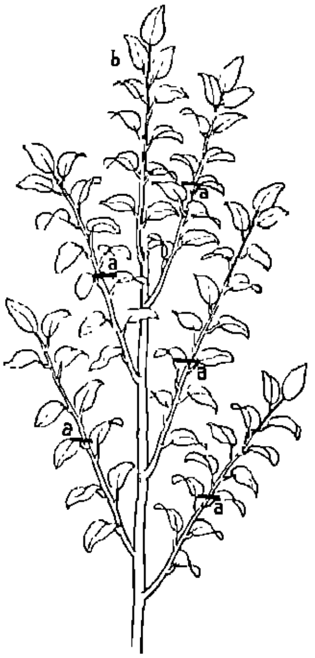


FIG. 186. SHOWING HOW TO SUMMER PRUNE BUSH APPLE TREES

a. Cut at this point, five leaves from the base of each lateral shoot.
b. Leader not to be pruned.

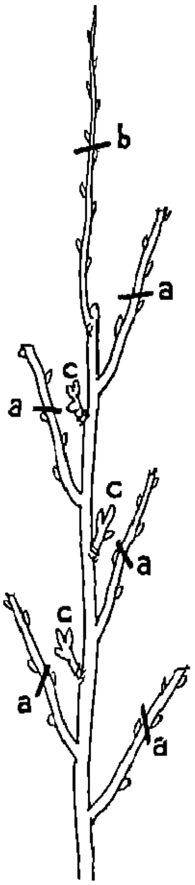


FIG. 187. SHOWING HOW TO WINTER-PRUNE BUSH APPLE TREES

a. Cut here, to within two eyes from the base of each lateral shoot.
b. Cut leader here—the unripened rip.
c. Natural fruit spurs.

Pruning cordon and espalier trees.—These trees are formed at planting time, hence subsequent pruning is on precisely the lines suggested for mature bush trees. One branch of a cordon or an espalier is exactly like that of a bush tree.

Pruning half standard and standard trees.—There is no orthodox method, no regular branch shortening, because the stocks on which these trees are worked induce the formation of an abundance of natural fruit spurs. Every season, after leaf fall, cut out entirely weak and dead wood, and the worse of each two crossing branches.

Feeding.—After trees come to bearing, apply each February as far as the branches stretch a 2 oz. per square yard application of a mixture of equal parts superphosphate of lime and sulphate of potash, to assist the fruit and harden the growth. Every third November mulch as far as the branches stretch with a 3 in. layer of well-rotted stable manure. If the trees are in grass, allow this nitrogenous, humus-forming mulch to wash down; if in arable land, fork in the residue in spring.

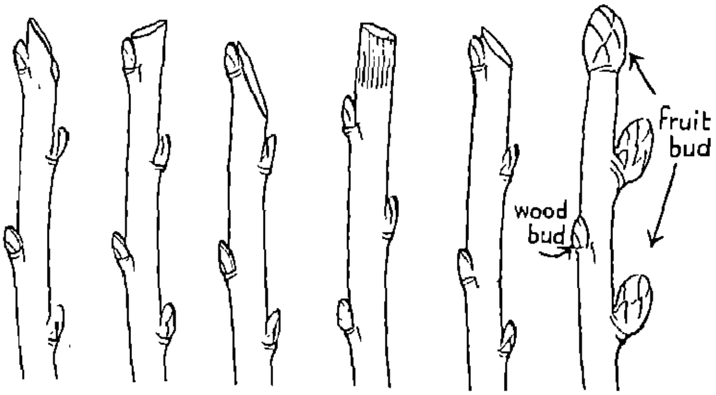


FIG. 188. SOME EXAMPLES OF GOOD AND BAD PRUNING

From left to right the drawings show:
Correct way to prune a shoot. The cut is made immediately above the selected bud.
Two incorrect methods of pruning.
Incorrect way of pruning to a wood bud to induce a further new shoot—It is not pruned close enough to a bud, thus there is a "snag" which will die.
Incorrect method of pruning a shoot.
Correct method of pruning to a wood bud to encourage a further shoot.

Spraying.—By a system of preventive spraying, it is possible to keep apple trees fairly free from pests and diseases. The following is an excellent programme:—

In December, when growth is dormant, spray with tar-oil winter wash to destroy the eggs of aphides and apple suckers. When the blossoms are in the green bud stage, spray with lime sulphur solution (1 pint in 4 gallons of water). When the blossoms fall, spray with a similar solution, as a safeguard against scab disease. As a safeguard against apple blossom weevil attack dry spray the open blossoms with derris powder. Watch for the appearance of red spider on the under surface of the leaves, and immediately it appears exterminate it by spraying with a summer petroleum wash. Caterpillars can be kept at bay by grease-banding the trees in October as described in a previous chapter.

Trees in grass.—When apple trees are planted in grass land, an area as far as the branches extend must be maintained in an arable condition until the trees are fully mature, and are established in fruit bearing, to frustrate competition from grass roots. Afterwards allow the grass to creep up to the trunks.

Fruit gathering.—Each variety must be gathered at the right stage, otherwise it will be deficient in flavour, and in the case of late varieties, will shrivel in store. Following is a satisfactory test:—hold typical fruits in the hollow of the hand, and lift them upwards and sideways. If the footstalk separates easily from the tree, the variety concerned is ready for gathering. Choose a dry day, handle the fruit so carefully that bruising is impossible, and do not stand in the tree or rear ladders against it, otherwise the abrasions may be followed by canker.

Storage.—The ideal fruit room is a semi-dark, airy structure having a slightly humid atmosphere and a temperature range of between 35° and 40° F. Arrange the apples in single layers on clean stages or trays. Do not deposit them on straw or newspaper, otherwise the flavour of the fruit will be tainted by contact.

Varieties.—It is more satisfactory to grow a few good varieties than a large number, some of doubtful value. The following selection ensures a succession from August until April:—

Culinary:—Early Victoria (August to September), Lord Derby (September to January), Newton Wonder (December to April), Bramley's Seedling (December to April).

Dessert:—Irish Peach (August), Worcester Pearmain (September and October), Ellison's Orange (October and November), Cox's Orange Pippin (November to April).

Pears.—*The cultivation of pears so much* resembles that of apples that it would be superfluous to do more than point to the similarity. The types of tree, soil preparation, planting, pruning, and spraying, in fact, every detail of cultivation above recommended should be reproduced.

Varieties.—By selecting varieties carefully, it is possible to maintain a succession from early August until the end of March. The following are recommended:—Clapp's Favourite (August and September), Conference (October and November), Doyenne du Comice (November and December), Vicar of Winkfield (December and January), Winter Nelis (December to March). These varieties are equally fitted for cooking and dessert.

Plums.—The plum is the most important of the stone fruits. Though it succeeds in all parts of the country, the greatest success is obtained on limestone formations in the eastern half, where the average annual rainfall is considerably lower. Plums are even less successful than apples when the rainfall exceeds 40 in. per annum.

Types of tree.—The plum is grown as bush, half standard, standard, single, double and triple cordon, and fan-trained. The branches of the last named type, which is grown on walls and fences, spread like the ribs of a fan, *Fig. 189*. The bush is the most popular type, because it fruits early. Where there is wall space to fill, cordons or fans might well be introduced.

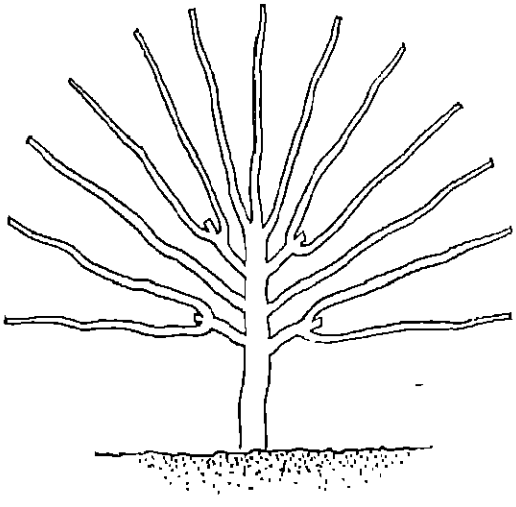


FIG. 189. FAN-TRAINED PLUM TREE

Aspect.—Plums give their best crop in a south or slightly south-east aspect. Being a specially early flowering tree, eastern aspects must be avoided on account of frost damage. When grown facing west, the fruit is very liable to split.

Drainage and shelter.—See the section on apples. The necessity for good drainage and shelter applies equally to plums.

Soil preparation—Choose land in good heart, and do not apply any stable manure. Dig it 1 ft. deep, working into each square yard 6 oz. of freshly slaked lime and 3 oz. of bone meal. Break down the lumps finely, tread firmly, and rake the surface even.

Planting period.—The same as for apples.

Age of tree.—As for apples, omitting espaliers and adding fan-trained trees, of which three-year-old specimens should be planted.

Planting method.—As for apples.

Staking.—As for apples.

Pruning bush trees.—Stone fruits do not like the knife, which when used excessively causes gummosis. Do not prune at all for twelve months. For the first, second, and third year, follow the programme advised for apples. Afterwards do no systematic pruning, but each season after leaf fall, cut out the weak and dead wood, the worse of each two crossing branches, and shorten any side shoots that are becoming inordinately long. The object is to ensure an open centre and a free circulation of air and sun amongst the branches. So long as this is done, plums crop freely.

Pruning cordon trees.—In this case more drastic methods must be followed. In July shorten each side shoot to within five or six good leaves from its base. After leaf fall, still further shorten each shoot to within two buds or eyes from its base. Remove the unripened tip of the leading shoot.

Pruning fan-trained trees.—In April remove the fore-right and the fore-aft shoots. The former grow towards the support, the latter away from it. In July shorten the side shoots to within five or six leaves from their base, and immediately after leaf fall, still further shorten each shoot to within two buds or eyes from its base. If there are more shoots than can be tied or nailed to the support, remove the weakest. Shorten the unripened tip of the leader. Trees of this type are not so liable to gummosis, owing to the fact that they were accustomed to the knife in very early life.

Pruning half standard and standard trees.—As for apples.

Feeding.—When the trees attain a fruit-bearing condition, apply each February, as far as the branches extend, a 2 oz. per square yard application of a mixture of 3 parts superphosphate of lime and 1 of sulphate of potash, which helps to maintain the right balance between growth and fruit bearing. Each October dress a similar area with freshly slaked lime at 4 oz. per square yard. Plums cannot stone their fruit unless they have command of an abundance of lime. Every third year mulch with a 3 in. layer of well-rotted stable manure as advised for apples.

Spraying.—Spray with a tar-oil winter wash each December, to destroy the eggs of aphides, which are very destructive on plums. Further regular preventive spraying is unnecessary. If aphides attack, destroy them by spraying with a nicotine wash. If Brown Wilt disease occurs, exterminate the fungus by spraying with liver of sulphur (1 oz. in three gallons of water). Grease-band the trees in October, as described in a previous chapter.

Trees in grass.—As for apples.

Fruit gathering.—Use infinite care, as when branches are broken, the susceptibility to silver leaf disease is increased. When the crop is very heavy, it is advisable to support the branches. Buyers demand that stalks are retained in picking to prevent early decay of fruit.

Storage.—Only rarely are plums stored, though the practice is increasing. Provided the fruit is gathered in prime condition, and each one wrapped in oiled paper, specially supplied for the purpose, the fruit will keep in good condition for several weeks.

Over vigorous trees.—Plum trees are very liable to become over exuberant, and cease to bear fruit. This condition can be rectified by bark ringing. At 2 ft. above the soil level remove a half inch wide strip of bark three quarters of the way round the main stem. Take care to remove the bark only. Immediately afterwards, protect the cut part with sticking plaster or adhesive tape, to prevent the entrance of disease spores. The effect of this treatment is to retard the flow of sap, restrain the vigorous growth, and throw the tree into a fruit-bearing condition.

Varieties.—The following is an excellent selection of culinary plums:—Rivers' Early (July), Czar (early to mid-August), Prosperity (mid to end August), Victoria (early to mid-September), Monarch (mid to end September).

Here are delicious dessert varieties:—Blue Rock (early to mid-August), Early Transparent Gage (mid to end August), Jefferson (early to mid-September), Late Transparent Gage (mid to end September), Coe's Golden Drop (end September to mid-October).

Cherries.—In every respect cherry cultivation is similar to that described for the plum. It would be superfluous to repeat the details given.

Varieties.—Early Rivers (end of June), Governor Wood (early July), Bigarreau Frogmore (mid-July), Bigarreau Napoleon (end July), Turkey Black Heart (early August), Emperor Francis (mid-August). These varieties are equally suitable for cooking or dessert. Morello, which ripens in August is the only true culinary cherry.

USEFUL HINTS

Prevention of frost damage.—Recent research work on this important matter proves that by the use of specially constructed lamps, it is possible to prevent frost damage. During the blossoming period, the lamps are set out in the orchards, all ready trimmed, so that if there is a rapid radiation of heat in the evening, they can be lighted. In large commercial orchards a bell fixed in the grower's house is connected to a thermometer. When the mercury falls to within two or three degrees of freezing point, the ringing bell warns the grower that he must take immediate action.

Soil preparation.—When preparing the soil for apples, pears, plums, and cherries, do not break the hard pan that immediately underlies the top one foot layer, otherwise the tree roots will plunge into the subsoil, and gross, unfruitful growth will result.

Root trimming.—When fruit trees arrive from the nursery, there is almost sure to be slight bruising and an occasional breakage. In every case cut off the root immediately above the seat of injury. If the damaged part is planted, the decay will spread.

Planting distances.—The following are appropriate:—single cordon 2 ft., double cordon 3 ft., triple cordon 4 ft., bush 12 ft., half standard 15 ft., standard 30 ft., espalier 15 ft. These distances apply to all the kinds of fruit trees mentioned in this chapter.

Examine stored fruit.—Examine stored fruit every three or four weeks removing any specimens that show signs of decay. A little lime sprinkled on the floor under the benches helps to absorb the bad gases that cause deterioration.

Thinning apples and pears.—Towards the end of June there occurs what is known as "the June drop." The tree then sheds the fruit it cannot mature. It does not, however, always shed sufficient, hence as soon as the June drop is over, the remaining fruit should be thinned to 9 in. apart. This not only improves quality, but eliminates to a large extent the biennial bearing habit.

Planting plums in heavy land.—Even though the drainage of heavy land may be arranged on orthodox lines, there is always a risk of standing water in a wet season. To avoid this, it is a good plan to set the roots on the surface, heap up soil over them, and stake firmly.

CLASSROOM WORK

Types of cut.—Bring to the classroom a typical fruit tree branch, or if this cannot be spared, the branch of a forest tree such as the sycamore. Demonstrate the right type of cut to make when pruning, namely a slanting cut immediately above the selected bud or eye. Demonstrate also the wrong type of cut, namely, the horizontal, and the internodal.

Pest-infested apple and pear branches.—A day or two before spraying with tar-oil washes, bring into the classroom a few apple, pear, plum, and cherry twigs. Show the children the clusters of aphides' eggs which will be found immediately beneath the bud scales. They are red or brownish red in colour, and round in shape.

Lime sulphur wash.—Prepare lime sulphur wash from the following formula:—flowers of sulphur 2 oz., quicklime 1½ lb., water 6 gallons. Pour boiling water over the lime in a wooden vessel, add the sulphur, and a little more boiling water. Leave the mixture to boil on its own. As soon as boiling ceases, which will be in about twenty minutes, add sufficient cold water to make 6 gallons. Stir well, and apply straight away.

Self sterility and partial self sterility.—Many varieties of apples, pears, plums, and cherries are self sterile or partially self sterile, which in the former case means that the flowers cannot be pollinated with their own pollen, and in the latter that pollination is not always successful. Make a list of the varieties in each category, and also of the varieties with which they are fertile. Here are a few:—

Apples.—Cox's Orange Pippin is fertile with Worcester Pearmain and Bramley's Seedling; Lane's Prince Albert with Bramley's Seedling and Cox's Orange Pippin.

Pears.—Doyenne du Comice with Pitmaston Duchess; Louise Bonne of Jersey with Marie Louise.

Plums.—Jefferson with Monarch and Early Rivers; Greengage with Victoria or Jefferson.

Cherries.—Black Tartarian with Governor Wood; May Duke with Morello.

Silver leaf disease.—Bring into the classroom a plum or cherry branch affected by silver leaf disease. Explain that the disease extends as far as the brown stain in the wood, and that when a branch is cut off, the whole of the brown stain must be removed.

XVI. FRUIT CULTIVATION (Continued)

NO collection of fruit can be considered complete unless small fruits are included. In this category are red currants, black currants, gooseberries, raspberries, loganberries, blackberries, and strawberries. The cultivation of each kind is dealt with separately.

Red currants.—Red currants are most successful in a sunny aspect, though they will succeed in partial shade. There are two types, bush and cordon. The latter are suitable for growing alongside walls and fences.

Soil preparation.—Dig. 2 ft. deep. Incorporate littery stable manure with the bottom one foot layer at the rate of one barrowful per 20 square yards. Mix a similar quantity of well-rotted manure with each 20 square yards of top 1 ft. layer. After breaking up the soil finely, and treading fairly firmly, rake into the surface 4 in. of each square yard 2 oz. of bone meal.

Planting period.—This extends from late October until the end of March. Autumn planting is preferable because at that season the soil is still warm enough to ensure rapid re-establishment.

Method of planting.—Set the bushes 5 ft. apart, arranging them alternately if more than one row is to be planted. For each specimen take out a hole wide enough to receive the outstretched roots, and deep enough to bury them at the level of the soil ring on the main stem. During frosty weather refirm lifted specimens, Fig. 190.

Pruning.—Red currants are definitely spur bearers, whether grown as bushes or cordons. This means that the side shoots on the main branches should be shortened half way back in July, and to within two buds or eyes from their base as soon after leaf fall as possible. Remove the unripened tip of the apical shoot on each main branch only. That provides for extension, and must not, therefore, be much restrained.

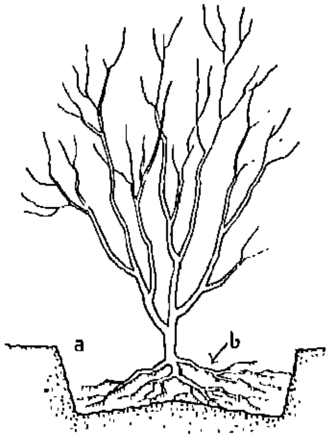


FIG. 190. SHOWING HOW TO PLANT RED CURRANT

a. Planting hole with inverted saucer-shaped bottom.
b. Outstretched roots.

Spraying.—In December spray with tar-oil winter wash, to destroy aphides' eggs. These are the only pests that need cause concern. If they attack in summer, spraying with liquid derris wash will destroy them.

It will also destroy the caterpillars of the gooseberry sawfly if they attack, but this is a rare event.

Varieties.—La Hative (early), New Red Dutch (mid-season), Rivers' Late Red (late).

Black currants.—These currants belong to the same genus (*Ribes*) as red currants. They rejoice in a rich, rather heavy soil; they do not object to slightly indifferent drainage, but must have abundant sunshine.

Soil preparation.—As for red currants.

Planting period.—As for red currants.

Method of planting.—As for red currants.

Pruning.—Black currants bear their fruit on one-year-old wood. Pruning aims at maintaining the maximum supply of this. Two or three weeks after planting, cut down each shoot to within two buds or eyes from its base. By so doing the first year's crop is sacrificed, but experience proves that black currants are not equal to the shock of transplanting and the strain of cropping in one season. The November after the first crop is gathered, remove the fruited wood. If no young growths arise towards the base, cut it off at the ground level. If young growth does arise, make the cut immediately above its point of origin. The young wood can easily be identified by its lighter colour. Until black currants attain maturity, they increase in size each year. After maturity, each season's output of young growth is more or less equal to that of the old, Fig. 191.

Spraying.—As for red currants, to destroy aphides' eggs. Another serious pest calls for mention here—the big bud mite (*Eriophyes ribes*). This almost microscopic pest feeds behind the bud scales, causing buds to swell to an abnormal size and become sterile. Hand picking and destruction of the affected buds is an essential part of the control campaign. Spraying with lime sulphur solution (1 part in 12 parts of water) destroys the mites when they are migrating from the old to the young buds.

Reversion.—This is a virus disease which completely disorganises growth and stultifies fruit production. The leaves of affected branches are much contracted. They are so much like those of a nettle that reversion is sometimes described as "nettlehead." Cut out and burn affected branches promptly, and sterilise the knife blade in boiling water, to prevent its carrying infection. The virus is in the sap, and is, therefore, inaccessible to spraying.

Varieties.—Boskoop Giant (early), Seabrook's Black (mid-season), Daniels' September (late).

Gooseberries.—Gooseberries, another member of the genus *Ribes*, succeed best in sunshine, but will do also in shade. When a long succession is desired, plantings are made in both aspects. There are three types, bushes having a clean leg or main

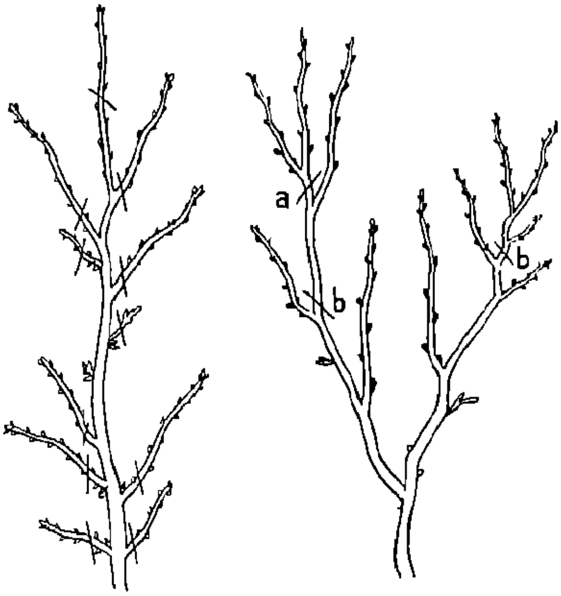


FIG. 191. PRUNING

The left-hand figure shows the method of pruning a red currant. The lines indicate where to prune lateral and leading shoots.

The right-hand drawings show the method of pruning a black currant. *a*. The old branch is cut back to a younger shoot. If it is cut back to *b*, the tree will be more compact.

stem 1 ft. above the ground level, bushes whose branches diverge at the ground level, and cordons. The last named are suitable for walls and fences. The clean legged is the better of the two first named types, the fruit being easier to gather, and less liable to soil splashing, Figs. 192 and 193.

Soil preparation.—As for red currants.

Planting period.—As for red currants.

Method of planting.—As for red currants.

Pruning.—There are two methods for bushes, the spur method, as described for red currants, and the extension method, which consists of cutting out each November sufficient old wood to give the young room for development. This may seem similar to the pruning of black currants, but actually is different. The main framework of the bush is retained. Only the old side branches are removed. Both methods yield excellent results. Cordons should always be spur pruned.

Spraying.—As for red currants, to destroy aphides' eggs. Dust with hellebore powder to kill the brightly coloured larvae of the gooseberry sawfly, which feed on the leaves. Similar treatment exterminates the larger larvae of the magpie moth, which feed in a similar way.

American gooseberry mildew.—This very serious foe is scheduled under the *Destructive Diseases and Pests Order.* A copy of the Order is obtainable from The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, London, S.W.1. The disease attacks leaves, fruit, and stems, greatly distorting them. The treatment advised in the Order should be strictly carried out.

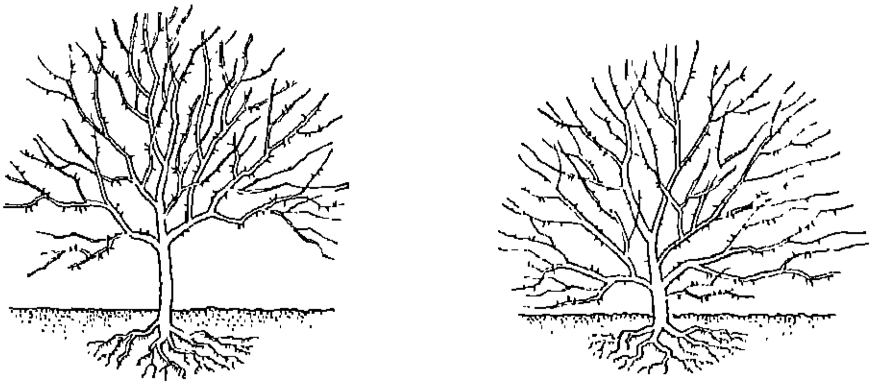
Varieties.—

Red: May Duke (early), Speedwell (mid-season), Lancashire Lad (late).

White: Whitesmith (early), Careless (mid-season), White Lion (late).

Green: Angler (early), Keepsake (mid-season), Thumper (late).

Yellow: Leader (early), Leveller (mid-season), Duck Wing (late).



Figs. 192 and 193. Types of Gooseberry

The left-hand drawing shows a clean legged type of gooseberry.
The right-hand drawing shows the bush type of gooseberry.

Raspberries.—Raspberries like a sunny situation and a well drained soil. There is only one type, known as a stool, which is a vigorous root system from which suckers spring.

Soil preparation.—Dig 2 ft. deep. Incorporate littery stable manure with the bottom 1 ft. layer at the rate of one barrowful per 15 square yards. Mix a similar quantity of well-rotted stable manure with each 15 square yards of top 1 ft. layer. Break up the soil finely, tread firmly, and when raking the surface even, work into each square yard 2 oz. of bone meal and 4 oz. of wood ashes, the latter to supply potash, which is a vital need.

Planting period.—As for red currants.

Method of planting.—Drive in substantial stakes rising 5 ft. above the soil level in rows 5 ft. apart, the stakes in the rows to be 9 ft. apart. Stretch wires between the stakes at intervals of 15 in. Set the stools 2 ft. asunder.

Pruning.—Raspberries are young wood bearers. They carry their fruit on one-year-old shoots or canes. Like black currants, the stools are not equal to meeting the check of transplanting and the strain of cropping in one season. Two or three weeks after planting, therefore, cut down the canes to the ground level. Immediately after the first crop has been gathered, cut down the fruited canes to the ground level, Fig. 194.

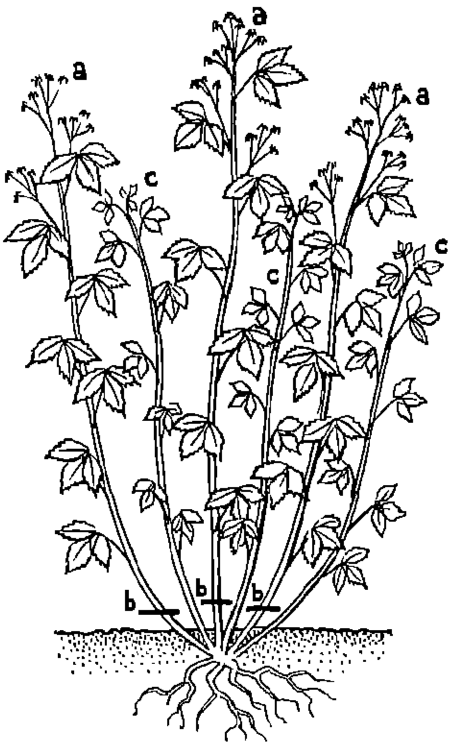


FIG. 194. SHOWING HOW TO PRUNE RASPBERRY

a. Fruited cane.
b. Cut out fruited cane here.
c. Young suckers to be retained for fruiting next year.

Regulation of suckers.—Each season the stools throw up far more suckers than can possibly develop into healthy fruiting canes. When it is seen which are the most vigorous, retain six of these per stool. Remove the remainder, cutting them off where they arise on the roots, to prevent branched suckers developing from the stubs.

Spraying.—In December spray with tar-oil winter wash, to destroy aphides' eggs. Just as the flowers are opening, and again just before petal-fall, dust them with derris powder, to destroy or paralyse the raspberry beetle, which at that time is laying the eggs that later on hatch into fruit-destroying maggots.

The life of a raspberry bed.—As a rule a stock is exhausted after twelve years, and becomes too uneconomic to retain. Arrangements should be made to have a young bed at the bearing stage when the old one is destroyed.

Varieties.—

Red: Red Cross (early), Lloyd George (mid-season), October Red (late).

Yellow: Antwerp (early), Surprise d' Automne (late).

Loganberries.—Loganberries make very vigorous growth. They are ideal for covering fences and walls, and for training up 8 ft. poles. They prefer a sunny situation, but will succeed in partial shade.

Soil preparation.—Prepare for each specimen a 3 ft. wide, 2 ft. deep station. Space the stations 8 ft. apart. At the bottom of each, place a 2 in. layer of rubble for drainage. When returning the bottom 1 ft. layer, mix with it ¾ pailful of littery farmyard manure. Mix a similar quantity of well-rotted manure with the top 1 ft. layer. Break up the soil finely, and when raking the surface even, work in 3 oz. of bone meal and 4 oz. of wood ashes.

Planting period.—As for red currants.

Method of planting.—As for red currants.

Pruning.—As for raspberries. Loganberries bear their fruit on one-year-old wood.

Spraying.—In December spray with tar-oil winter wash, to destroy aphides' eggs. Dust with derris powder as advised for raspberries to control the raspberry and loganberry beetle.

Varieties.—There are no named varieties, but there are several types, some of them very inferior. It is, therefore, necessary to secure a good stock from a reliable source.

Blackberries.—No blackberry indigenous to Great Britain is cultivated in gardens, but two American varieties are. They bear heavy crops of large, luscious berries, and being autumn fruiters, should be included to maintain a succession. Plant in position similar to those advised for loganberries.

Soil preparation.—As for loganberries.

Planting period.—As for red currants.

Method of planting.—As for loganberries.

Pruning.—As for raspberries. The blackberry bears its fruit on one-year-old wood.

Spraying.—Spray in December with winter tar-oil wash, to destroy aphides' eggs. Dust the flowers as suggested for raspberries, to control the raspberry and loganberry beetle.

Varieties.—Snyder and Wilson Junior.

Strawberries.—Strawberries demand abundant sunshine, free drainage, and if possible shelter from the east, as a protection against frost damage when the flowers are in bloom.

Soil preparation.—Dig 2 ft. deep. Mix with each 10 square yards of bottom spit half a cwt. of littery farmyard manure. With each ten square yards of top spit mix a similar quantity of well-rotted farmyard manure. Break down the lumps finely, and after treading fairly firmly, rake in a 2 oz. per square yard dressing of bone meal.

Planting period.—September and October are the two best months. The plants must have plenty of time to root well before winter. Plantings may also be made in February and March, but when they are deferred so late, the first year's crop is very poor.

Method of planting.—Space the rows 28 in. apart, the plants in the rows, 14 in. Immediately before planting, steep the roots in water heated to a temperature of 100° F., for twenty minutes, as a safeguard against eelworm attack. When planting, take care not to bury the growing point, or the plants concerned will perish. If dry weather succeeds planting, water regularly until growth restarts. During the first winter, re-firm plants that are lifted by frost, Fig. 195.

The life of a strawberry bed.—A strawberry bed remains economic for three years, after which it should be destroyed. The largest, best fruit is borne during the first year, but the yield is

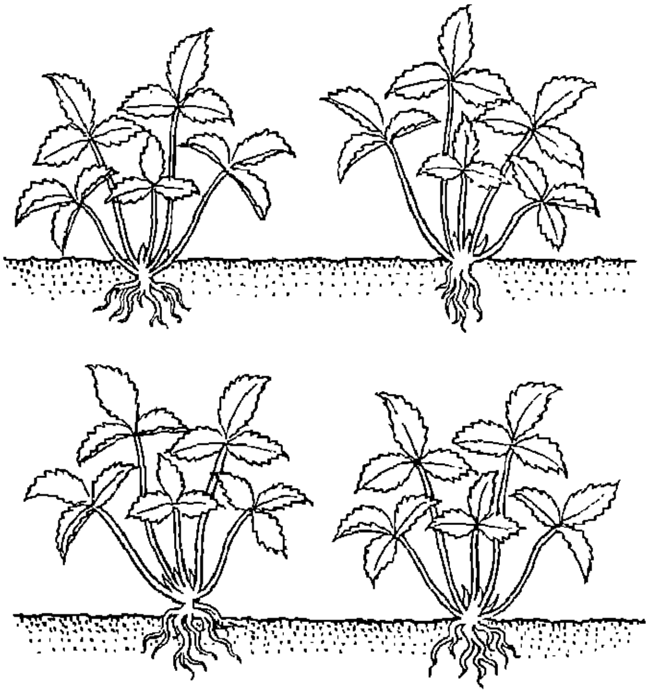


FIG. 195. PLANTING STRAWBERRIES

From left to right the drawings show:
In the top row: a strawberry planted too deeply; planted with the roots cramped.
In the bottom row: a strawberry planted too high; planted correctly.

comparatively light. A heavy, excellently flavoured crop is borne during the second year. In the third year, weight and quality decline slightly. To maintain the desired strawberry area, divide it into three sections—section one being for the one-year-olds, section two for the two-year-olds, section three for the three-year-olds. Section three is destroyed each year, and an equivalent number of young plants put in.

Propagation.—Strawberries are propagated by runners formed on the parent plants. There may be several runners on each plant, and two or more young plants on each runner. The runner nearest the parent should always be used for propagation. Second and third runners are invariably sterile. In July detach the required number, and plant them 6 in. apart in a moderately rich, sunny nursery bed, transferring them to the final quarters in September. An alternative method is to peg the runners down in half plunged 3 in. pots. As there is less risk of root disturbance at the final planting time, this is the better method, but owing to the labour involved in constant watering is not often practised, Fig. 196.

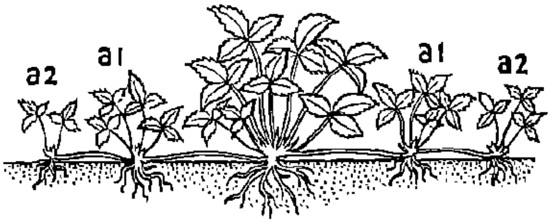


FIG. 196. STRAWBERRY PLANT DEVELOPING RUNNERS

*a*1, *a*2. Runners.
*a*1. Fertile Runners.
*a*2. Sterile Runners.

Strawing.—As soon as the fruit starts swelling freely, place a layer of clean straw round the plants, to prevent soil splashing, and reduce the risk of slug attack. At this stage remove very small, deformed berries, which remain hard, and on ripening possess an indifferent flavour.

Netting.—Just before the fruit starts to colour, cover the bed with fish netting as a protection against bird attack. Lay the netting over a light wood framework, to safeguard the plants from damage.

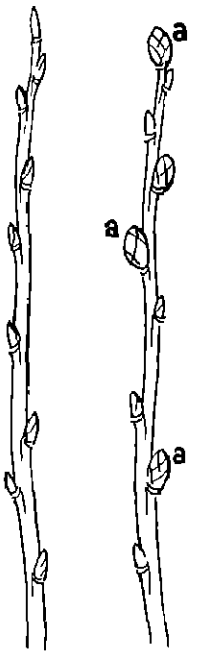
After fruiting.—Remove the net, and cut off the old leaves, burning them to destroy the red spiders' eggs which are sure to be deposited on them. Mulch with a 2 in. layer of well-rotted stable manure, forking in the residue lightly the following March.

Spraying.—At the end of March, just as young growth is beginning to develop, spray with nicotine insecticide to destroy the tarsonemid mites which at that period are just hatching. If mildew attacks during summer, spray with liver of sulphur solution immediately after the fruit is gathered. The symptoms are mealy white, down-covered leaves.

Varieties.—Leader (early), Royal Sovereign (early), Oberschlesien (mid-season), Fillbasket (mid-season), Tardive de Leopold (late), Waterloo (late).

USEFUL HINTS

Prune overgrown red currants.—Even when red currants are pruned in an orthodox way they become overgrown and ungainly after a few years. This is natural. The spurs must lengthen, since the current year's wood is shortened to within two eyes from its base each winter. When the bushes become unmanageable, cut each main branch two-thirds of the way back, and reform the bush from the resulting young growth.



FIGS. 197 AND 198. BLACK CURRANT BRANCHES

The left-hand drawing shows a normal black currant branch. Note the pointed leaf buds.
The right-hand drawing illustrates a branch infested by Big Bud Mite.
a, Mite-infested buds.

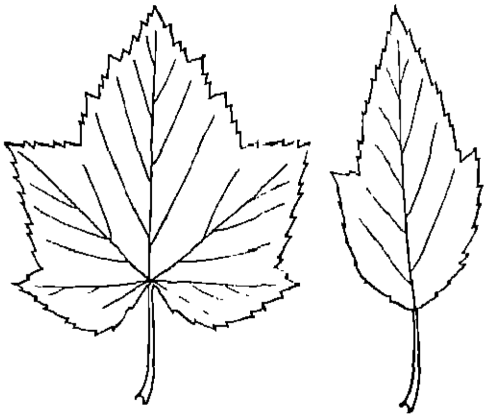
Big bud mite on black currants.—Black currants are frequently infested with this serious pest from hazel bushes growing in the vicinity. The mite which infests the hazel is a distinct species, nevertheless it passes to the black currant. If, therefore, hazel bushes in the vicinity have swollen buds, these should, as a hygienic precaution, be picked off, Figs. 197 and 198.

Reversion in black currants.—Aphides or green flies carry the virus which causes reversion. It is, therefore, very important to apply remedial measures should this pest attack. The best of these is to spray promptly with a non-poisonous derris wash, choosing a calm, dull day or evening, Figs. 199 and 200.

Die-back in gooseberries.—Very often the mature branches of gooseberries die back suddenly while in full leaf. The cause is a botrytis fungus which works internally. Spraying is, therefore, of no avail. Cut off and burn affected branches at once, as the disease is infectious.

Raspberry mosaic disease.—This is a virus trouble similar to that which causes reversion in black currants. In this case the leaves retain their normal shape, but develop a yellow variegation. They are quite sterile. To prevent the trouble spreading, cut out and burn affected branches, and sterilise the knife blade in boiling water.

Raspberry fruit thinning.—On raspberry fruit clusters there is always a proportion of small, inferior fruit. If this is allowed to remain, the seed in each drupelet will develop, and in doing so absorb a lot of nutriment. Considering that it has no table value, the best course is to clip it off as soon as its futile character is obvious.



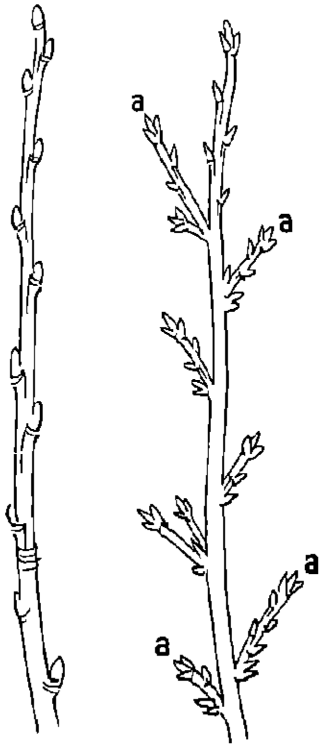
FIGS. 199 AND 200. BLACK CURRANT LEAVES

The left-hand drawing shows a normal black currant leaf.
The right-hand diagram shows a black currant leaf affected by Reversion or Nettlehead.

CLASSROOM WORK

Black and red currant branches.—Bring to the classroom a typical branch from a black and red currant respectively. Explain that the former has no fruit spurs, and that the latter has. Follow with a description of the pruning methods, making it clear that the black currant bears its fruit on one year old wood, which must, therefore, be retained at pruning time, Figs. 201 and 202.

Big bud mite on black currants.—Bring to the classroom a number of shoots bearing mite-infested buds. Place the shoots in water, and examine the water twenty-four hours later. Shoals of mites will be seen floating on the surface. Explain that the mites are responsible for the malformation of the buds, and give remedies.



FIGS. 201 AND 202. CURRANTS

The left-hand drawing shows a black currant branch. Note the absence of fruit spurs.

The right-hand drawing shows a red currant branch. *a*. Fruit spurs.

Strawberry forcing.—Plant a few strawberry runners in 5 in. pots. Use a compost of loam 4 parts, well-rotted manure, lime rubble, and sand 1 part each. Stand the pots in a light window in the classroom. Water them carefully. Turn the plants round every few days, to maintain even growth. When flowers open, dust them daily with a rabbit's tail or camel's hair brush to distribute the pollen and ensure a good set of fruit. In this way a batch of strawberries will ripen in mid-winter.

Tarsonemid mite.—In early February bring into the classroom a few old strawberry leaves. Examine the under surface, on which some of the small red eggs of the tarsonemid mite are sure to be seen. Place them under a bell glass, tilting the latter to admit a little air. Watch the mites hatch. Point out that this is one of the most serious pests of the strawberry and that the outdoor plants must be sprayed with nicotine insecticide in early spring to kill the mites as they hatch out.

Clonal strains of strawberries.—Point out that during the war strawberry stocks were allowed to degenerate. At the end of the period they were so far exhausted that strawberry growing became uneconomic. At research stations good fruit-bearing types were evolved. These are known as clonal strains. When purchasing new stocks it is always advisable to secure them.

XVII. EXPERIMENTS

The value of experiments in the school gardening scheme.—The school gardening scheme is incomplete without experiments. In their absence, the various operations fall into the rule-of-thumb category. Everything must be accepted on trust. There is abundant scope, and the work is exceedingly interesting.

An experiment defined.—An experiment is an effort to demonstrate the truth by a comparative test. There must be some control with which the principle demonstrated can be compared, otherwise no experiment has any educational value. In every case the object of the experiment must be clearly defined. To give an example. If the experiment seeks to demonstrate the ameliorative influence of the elements on soil texture, a good description would be "To demonstrate the effect of frost, thaw, rain, snow, wind, and air on the texture of cultivated land."

Records.—Faithful records must be kept throughout—the date on which the experiment was set up; dates of sowing, planting, transplanting; rate of progress of each partner in the experiment, and the results. The records should be so complete that a perfect stranger examining them would know exactly the aim and the result without asking any questions.

The position of experiments in the scheme.—Though children in their third year are better equipped mentally to understand experimental work, it is helpful to initiate them in their first and second years, choosing simple, easily understood tests, passing to the more complex in the third year. The experimental scheme that follows begins with the simple, progressing gradually to the more complex.

Experiment 1.—To demonstrate the effect on yield of suckering Longpod broad beans.

Experiment explained.—There is some controversy as to whether the basal side shoots or suckers developed by Longpod broad beans should be retained or removed. This experiment will afford reliable guidance on the matter.

Variety.—Seville Giant Longpod.

Date of sowing.—The first week in November.

Soil preparation.—Prepare 2 ft. deep trenches; with each yard run of bottom 1 ft. layer mix ½ pailful of littery stable manure and 2 oz. of crushed bones. With each yard run of top layer incorporate a similar quantity of well-rotted manure and bone meal. Break up the soil finely, and tread fairly firmly.

Method of sowing.—Form 9 in. wide, 3 in. deep, flat-bottomed drills. In each drill, sow two rows of seed alternately at an all-round distance of 6 in. apart.

Number of drills and distance apart.—Sow two drills at 2 ft. apart, the plants in one row to be suckered, those in the other to be untouched, thus acting as a control.

Winter treatment.—Hoe whenever the soil shows signs of caking. Apply monthly dressings of weathered soot at 2 ozs. per yard run.

Removal of suckers.—In spring watch for the development of suckers, removing these growths from the one row when they are 2 in. long. Given a sharp twist with the finger and thumb, the suckers will come off cleanly, Fig. 203.

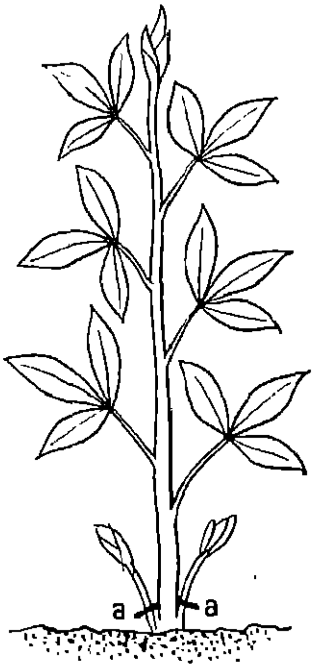


FIG. 203. BROAD BEAN PLANT DEVELOPING SUCKERS
a. Remove suckers at this point.

Feeding.—From the time the first flowers fall until the last pod is picked, feed weekly with superphosphate of lime at 1 oz. per yard run of drill, hoeing the fertiliser in if the soil is moist, watering it in should it be dry.

Stopping.—Remove the growing points one leaf above the last flower, to concentrate nutriment in the developing pods.

Result of experiment.—Take careful records of the gathering dates and the weight of produce yielded by each row. The one giving the heavier crop must reflect the better course of treatment. A subsidiary point is the date on which the ground can be cleared for succession crops.

Experiment 2.—To test the cropping capacity and cooking quality of round-seeded and wrinkled-seeded or marrowfat peas respectively.

Experiment explained.—There are two sections of peas—round-seeded and wrinkled-seeded. It is generally conceded that the latter give the heavier crops and possess a superior culinary quality. Take the matter out of the region of conjecture by instituting an experiment.

Round-seeded varieties to be tested.—Benefactor, Early Bird, Foremost, British Lion, and Eclipse.

Wrinkled-seeded varieties to be tested.—Bedford Champion, Thomas Laxton, World's Record, Exquisite and Gradus.

Classification of varieties.—All are first earlies, and all 3 ft. tall.

Date of sowing.—The third week in March.

Soil preparation.—As for broad beans.

Number of drills and distance apart.—Sow one drill of each variety, and space the drills 3 ft. apart.

Early treatment.—When the seedlings are 1 in. tall, apply 1 oz. per yard run dressing of superphosphate of lime, to accelerate root action. Support the plants with 3 ft. tall, bushy tree branches when the tendrils show.

Feeding and stopping.—As for broad beans.

Result of experiment.—Carefully weigh the shelled produce from each row. That is the real test of effective yield. Institute a cooking test of each variety when the peas are in the prime of condition. The criteria of quality are, thinness of skin 20 points; sweetness 40; succulence 40.

Experiment 3.—To demonstrate the effect on flowering of stopping sweet peas when the plants are 5 in. tall.

Experiment explained.—There are two methods of growing sweet peas. One consists of allowing the plants to flower on the maiden or unstopped stems, the other of stopping, or removing the growing point of each plant at 5 in. tall, and retaining on each the best resulting side shoot. The experiment will clear up doubts as to which is the better way.

Variety.—Sextet Queen.

Date of sowing.—The first week in October.

Method of sowing.—Set twenty-four seeds separately in clean 2 in. pots. Use a riddled compost of loam 3 parts, leaf mould, lime rubble, and sand 1 part each. Bury each seed ¼ in deep. Place the pots in a cold frame.

Winter treatment.—Water carefully, keep the glass clean, and ventilate as freely as the weather allows.

Soil preparation.—Prepare in early January a trench as suggested for broad beans.

Planting out.—Plant out at 9 in. apart the first week in April. Support each plant with a 7 ft. tall, sturdy stake. Tie each plant regularly.

Stopping.—When the plants are 5 in. tall, remove the growing point from alternate specimens. Retain the strongest resulting side shoot on each, Fig. 204 and 205.

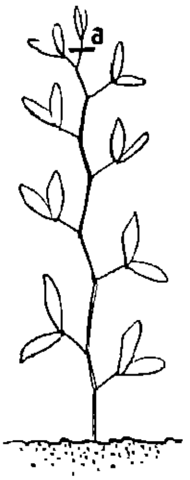


FIG. 204. 5 IN. TALL SWEET PEA READY FOR STOPPING

a. Remove growing point here.

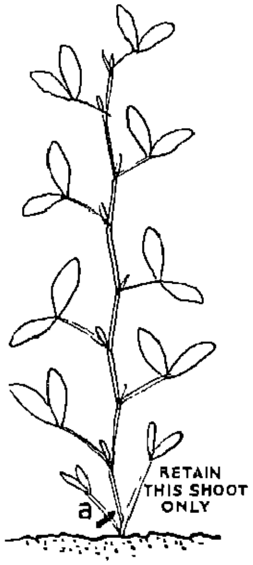


FIG. 205. SWEET PEA DEVELOPING SIDE SHOOTS AS A RESULT OF STOPPING. REMOVE SHOOT AT *a* AND ORIGINAL MAIN SHOOT

Tendril and side shoot removal.—From every plant in the experiment remove the side shoots that arise in the leaf joints, when they are an inch long. Also clip off the tendrils at the leaf ends. These are not needed for support, Fig. 206.

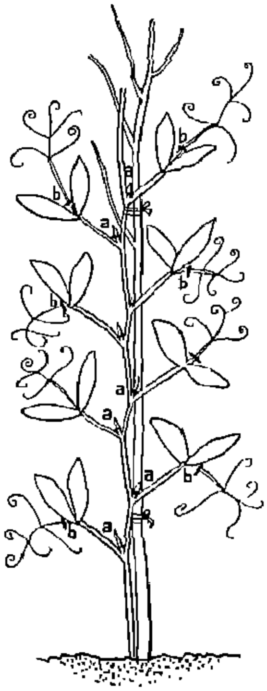


FIG. 206. SWEET PEA PLANT DEVELOPING TENDRILS AND SIDE SHOOTS, BOTH READY FOR REMOVAL

a. Remove side shoots here.
b. Remove tendrils here.

Feeding.—After the first buds show, feed weekly with a mixture of 4 parts superphosphate of lime, and 1 part each of sulphate of ammonia and sulphate of potash until the end of the flowering season. Give each plant a teaspoonful per dose, watering or stirring in the mixture in accordance with the condition of the soil.

Result of experiment.—In assessing the result of the experiment, the points to be noted are:—(1) The number of buds which drop prematurely on each stopped and unstopped plant respectively. (2) The earliest date on which flowers open, and the plants on which they do open—stopped or unstopped. (3) The quality of the bloom, that is, length, strength, and straightness of stem, number of flowers on each stem, form of flower, and date on which flowering ceases. When the performance of the two partners in the experiment is compared on these lines, a definite lead will be given as to the value or otherwise of stopping.

Experiment 4.—To demonstrate the effect of potash manuring on raspberries.

Experiment explained.—Raspberries are said to be dependent in large measure on a readily available, continuing supply of potash during the growing and fruiting season. In its absence it is stated that the yield suffers, while the berries are smaller and less succulent. The experiment will afford some light on this matter.

Experimental scheme.—Adjacent rows should not be treated, otherwise there may be a seepage of fertiliser to the control row, vitiating the result. At least 10 ft. should divide the treated and the untreated.

Variety.—Any variety may be taken, but it is essential that the same variety shall occur in the treated as in the untreated row.

Number of rows.—Two, one treated, the other untreated with potash.

Treatment of the treated row.—Immediately after pruning, in August or September, fork into the bed a 4 oz. per yard run dressing of wood ashes, a fertiliser rich in potash. In late February, just as the leaves are bursting, and again immediately before the flowers open, dress with sulphate of potash at the rate of 2 oz. per yard run of row.

Result of experiment.—In assessing the result of this experiment, observe the following points:—(1) The weight of fruit gathered from the treated and the untreated rows respectively. (2) Note on each row the number of fruits which refuse to colour, and tend to dry up. (3) The number of flowers on each row which fail to set fruit. (4) The number of berries needed to make 1 lb. on the treated and untreated rows respectively (the largest berries are the juiciest). (5) The size of the plug or core, in twenty-four fruits taken at random from each of the two rows. Obviously the larger the plug, the smaller the consumable fruit.

Experiment 5.—To demonstrate the value or otherwise of sprouting seed potatoes.

Experiment explained.—The sprouting of seed potatoes consists of forwarding growth in shallow boxes before planting out. What is the effect of the process on yield and freedom from disease?

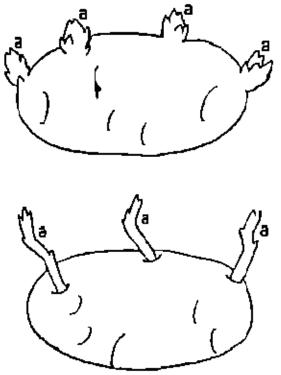
Variety.—Arran Banner. Plant thirty-six sprouted and thirty-six unsprouted tubers.

Date when sprouting should commence.—First week in January.

Method of sprouting.—Set up the tubers close together in shallow boxes with the round end upwards.

Sprouting environment.—A cool, light room or shed having a temperature range of 35° to 45° F.

Observations during the sprouting period.—If any tubers stubbornly refuse to sprout, or sprout very weakly, burn them. They are affected by virus disease. If green fly attacks the sprouts, destroy it by spraying with nicotine insecticide. This pest is a transmitter of the virus trouble, Figs. 207 and 208.



FIGS. 207 AND 208. THE DEVELOPMENT OF SEED POTATOES

The top drawing shows a seed potato developing vigorous sprouts. *a*. Sprout.
The lower drawing shows a seed potato developing weakly sprouts, the result of Virus disease. Reject tubers of this type. *a*. Sprout.

Soil preparation.—Dig the selected site 1 ft. deep. Take out V-shaped trenches 8 in. deep and 28 in. apart. At the bottom of each trench place a 3 in. layer of littery stable manure.

Planting date.—First week in April.

Distance apart.—Space the tubers 14 in. apart. Handle the sprouted ones very carefully to avoid damage.

Feeding.—Immediately before earthing up, dress with a mixture of 3 parts superphosphate of lime and 2 parts sulphate of potash at $1\frac{1}{2}$ oz. per yard run of drill.

Earthing up.—Draw up to each side of the plants, when they are 10 in. tall, a 4 to 5 in. high bank of finely pulverised soil.

Spraying.—In early July spray with Bordeaux Mixture as a safeguard against late blight disease.

Result of experiment.—In computing the result of this experiment, observe the following matters:—(1) The date on which the unsprouted and the sprouted growth appear above ground. (2) The number of gaps in the sprouted and unsprouted rows respectively. It can safely be assumed that the gaps which are sure to occur in the unsprouted batch are accounted for by virus disease. (3) Evenness of growth. Compare the two partners in the experiment. If there is unevenness anywhere, the smaller plants are not receiving their fair share of light. (4) Yield. Make a record of the lifting dates, and weigh carefully the crop from the sprouted and unsprouted seed. Grade both into ware and chats and record these.

Experiment 6.—To demonstrate the value or otherwise of aerating the lawn.

Experiment explained.—One of the main factors in a successful lawn is an even, firm surface. Without it, mowing cannot be done properly, while the machine is subject to injury. Further, neither games nor comfort are possible on an uneven surface. To ensure evenness, considerable rolling is necessary. This creates air-logging, which destroys the finer grasses, and gives the rein to the coarser, and weeds such as *plantains and dandelions. The object of the* experiment is to prove that a purer, better turf is obtained by aerating the soil with a garden fork.

The experimental scheme.—Delineate two, 1 yard wide lawn strips as far apart as possible. Keep the lines in position for twelve months, the period during which the experiment runs.

Method of aeration.—Push in the tines of the garden fork 4 in. deep, treating the whole of 1 yard wide strip. The tines of the average fork are 3½ in. apart. This means that there will be 4 in. deep holes spaced 3½ in. apart, Fig. 209.

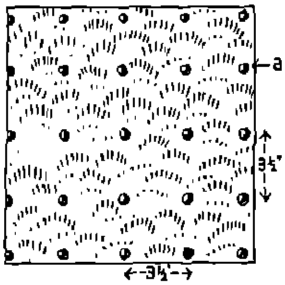


FIG. 209. SQUARE OF TURF SPIKED 4 IN. DEEP WITH GARDEN FORK
The holes are 3½ in. apart.
a, hole.

When to aerate.—Starting in early August, spike the lawn at two-monthly intervals until the following August.

Result of experiment.—As soon as the experiment closes, make the following records:—(1) Count the number of weeds on each yard wide strip. (2) Count the number of tussocks of rough grass such as Yorkshire fog and bent grass on each yard wide strip. (3) Note the degree of greenness of the turf on each strip. (4) Note the closeness of the turf on each strip, and on the data thus accumulated, judge the value of the experiment.

Experiment 7.—To demonstrate the value or otherwise of summer pruning bush apple trees.

Experiment explained.—Bush apple trees are budded or grafted on to paradise stocks, which induce somewhat gross growth. This *must be kept under control by pruning.* The process may be undertaken at two seasons—in July and January, or in January only. As the object of pruning is to induce the formation of the maximum number of fruit spurs, it follows that the method which has the better record in this respect should be practised. The experiment will give the necessary information.

The experimental scheme.—It is not advisable to operate on different trees of the same variety, as one of the trees may have some weakness not revealed by the other. This would spoil the result of the experiment. Take one tree. Divide it into two sections of equal size, giving to each section the treatment suggested below.

The treatment of Section A.—In July *shorten each side shoot on the main branches* to within six good leaves from its base. Make each cut immediately above the selected leaf. Do not touch the leading shoot on each main branch, as this provides for extension. In early January shorten each shoot pruned the previous July to within two good buds or eyes from its base.

The treatment of Section B.—Omit the July pruning, and prune in January as suggested for Section A.

Duration of experiment.—Differences will be noted the first year after the treatment, but will be more noticeable in the second and subsequent years. This experiment might, therefore, be maintained as a permanent feature.

Result of experiment.—In drawing up the *experiment, the points to be noted are:*—(1) The number of fruit spurs on each branch in Section A and Section B. (2) The quantity of premature fruit dropping in Section A and Section B. (3) The quality of the fruit in the two sections—size, colour, and flavour. (4) Weight of fruit.

Experiment 8.—To demonstrate the advantages or otherwise of August versus Spring sowing of hardy annuals.

Experiment explained.—The imposition of tariffs has greatly increased flower cultivation in Great Britain. Hardy annuals such as nigellas, annual chrysanthemums, larkspurs, and cornflowers are now available in early summer, from sowings made the previous August. This method cuts across previous conceptions. The object of the experiment is to demonstrate its practicability.

Varieties.—Pink larkspurs and blue cornflowers.

Soil preparation.—Dig 1 ft. deep, incorporating with each square yard ½ pailful of well-rotted stable manure. Do this in July for the August batch, in January for the spring batch. Break up the soil finely in each case, tread it fairly firmly, and rake the surface even.

Number of drills and distance apart.—Sow two drills of each kind 1 ft. apart.

Sowing dates.—The second week in August, and the third week in March.

Method of sowing.—Form 1 in. deep drills, spacing them 1 ft. apart.

Winter treatment of August-sown batch.—Give monthly dressings of weathered soot, keep the soil well stirred, and when the first severe spell threatens, protect the seedlings by placing short bushy branches on each side of the rows.

Thinning.—Do not thin the August-sown batch until growth starts in spring. Then gradually reduce the seedlings until they stand 1 ft. apart. Thin the March-sown batch when congestion arises.

Result of experiment.—The points to be noted are:—(1) The number of casualties, if any, in the August-sown batch. (2) The earliest date on which flowers can be cut from each batch. (3) The quality of the flowers in each—length of spike in larkspurs, colour and size of bloom in cornflowers. (4) Number of bunches of flowers (twelve spikes or sprays to the bunch) that are cut from each batch. On the strength of this data the honours in the experiment can be awarded.

Experiment 9.—To demonstrate the value of soil sterilisation in the raising of seedlings under glass.

Experiment explained.—It is well-known that the cleanest samples of soil harbour weed seeds, mould spores, grubs, and harmful bacteria, which embarrass small seedlings, sometimes destroying them entirely. This experiment will prove that sowing in sterilised soil frees the seedlings from injurious influences, thus facilitating healthy growth.

Experimental scheme.—Mix four pailfuls of a compost of loam 3 parts, leaf mould and sand 1 part each. Pass the ingredients through a ½ in. sieve, to ensure an even texture, and turn over the heap three or four times to get a good compost. Now separate the latter into four equal parts, each to receive separate treatment.

Pailful No. 1.—On this pour a solution made by stirring 2 medicinal drachms of commercial formalin into 5 pints of water. Turn over the heap once, cover it with sacks, and leave it for three weeks.

Pailful No. 2.—Heat this on an iron plate over a good fire for six hours, Fig. 210.

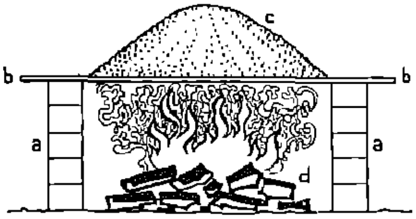


FIG. 210. APPARATUS FOR STERILISING SOIL
a. Brick pier. *b.* Iron plate. *c.* Soil. *d.* Fire.

Pailful No. 3.—Out of this pailful make up a seed box. Drain the bottom with an inch of rough compost, fill up fairly firmly to within ½ in. of the surface. After levelling the latter, water through a rosed can with boiling water.

Pailful No. 4.—This is the control. Fill up a seed box from it without any treatment at all.

General.—So arrange this experiment that seed can be grown in compost from pailfuls No. 1, 2, 3 and 4 respectively on the same date. It will mean that the treatment of Pailful No. 1 must start three weeks ahead of the others.

Subject suggested for experiment.—Tomato, variety Radio.

Date of sowing.—February 15th.

Method of sowing.—Space the seed ½ in. apart, just covering it with finely sifted compost, treated in each case in the same way as the general body of soil in the box. After covering the seed, cover the boxes with glass and brown paper, to ensure equable conditions during the germination period.

Sowing environment.—A greenhouse having a temperature of 60° to 65° F.

Later treatment.—As soon as the seedlings appear, remove the covers, and afford good light. For the first week, shade with tiffany when the sun shines brightly. Water carefully with clean aired water.

Result of experiment.—This is an important experiment, touching one of the foundation principles of modern gardening. Have careful records of the behaviour of the seedlings in each box. Note the rate of growth, the degree of greenness in the foliage, and most important of all, the degree of susceptibility to damping off. The compost in Pail No. 1 was sterilised by a pure chemical. It can confidently be expected that the seedlings growing in this compost will not succumb to damping off, and their foliage will be remarkably healthy. The compost in Pail No. 2 was sterilised by the old-fashioned method of soil burning. It is extremely unlikely that the seedlings growing in it will be attacked by the damping off fungus, but their growth will be halting and in a measure unsatisfactory, due to the consumption of a large amount of organic matter by the intense heat. In practice it is found that the iron plate becomes so hot that the soil actually reddens. The compost in Pail No. 3 was also sterilised in an old-time way. The effect is helpful, but incomplete. If all the soil could be soaked in boiling water, the result would be more encouraging, but the water cools on contact with the soil, and cools more on passing through. Thus some measure of trouble from soil enemies must be expected.

If it is desired to test the effect of sterilisation on later growth, the compost can be treated as advised above for all the stages through which the tomato crop passes. The value of complete sterilisation will be proved at every turn.

USEFUL HINTS

Experimental plot.—While many experiments can be conducted in the ordinary vegetable plots or in the ordinary flower borders, it is an advantage to set aside a special plot for this purpose. There is then less danger of vitiated results, while experiments assume greater importance in the minds of the children when they are isolated.

Records' rota.—The taking of accurate records is supremely important. It is work that should be shared to give all the children interest in the experiments from first to last. An excellent idea when setting up an experiment is to set up a records' rota also, assigning to each child some special bit of work or some period during which he is, under the supervision of the teacher, solely responsible for the records.

Removing broad bean suckers.—This, of course, is a surgical operation attended by a check. Reduce that check to the minimum by removing the suckers during showery weather, or a few hours after watering the plants. Under such conditions the suckers come away with less risk of stem peeling.

Culinary pea experiment.—Pea seeds frequently fail to germinate. It is advisable, therefore, to sow a few extra seeds of each variety used in this experiment in a reserve border to provide plants of even size for filling up gaps in the experimental rows.

Sweet pea experiment.—During winter the seedlings in this experiment may at times be so severely frozen as to look hopeless. There is not the least need to be concerned about them, nor to adopt any restorative measures. As soon as the frost departs, they will recover and grow normally.

Raspberry experiment.—When applying the wood ashes in this experiment, take great care not to injure the roots, otherwise the results will be vitiated by a profuse growth of suckers the following year. If the fork tines strike a root, withdraw them at once, and push in in another place.

Lawn experiment.—Do not spike the lawn when the soil is very moist, otherwise the fork tines will cause the sides of the holes to coagulate, and when they dry, to set like cement. Obviously a condition like this prevents efficient aeration. A reasonably dry soil condition is essential for a fair test of the principles involved.

CLASSROOM WORK

Broad bean experiment.—The results of this experiment would be all the more helpful if the seeds were shelled in school. Count the average number of seeds in the pods from the unsuckered and the suckered plants respectively.

Also count the number of vacant places in the pods of each partner in the experiment.

Culinary pea experiment.—In arranging the cooking test connected with this experiment, an excellent plan is to have a number of tripods and Bunsen burners. Put the same quantity of peas, water and salt into each saucepan, light all the Bunsens at the same time, and let the peas cook for twenty minutes. Then make the appraisement.

Potato experiment.—Before setting up this experiment, sort out the number of tubers required for each partner. As far as possible these should be of the same shape and size. If different sized seed tubers are used, it is quite possible that they may introduce a cross current, which would make the results less decisive and convincing.

Lawn aerating experiment.—Take into the classroom two 9 in. square blocks of turf, one from the unspiked, the other from the spiked section. Count the number of weeds, dandelions, daisies, etc., in each square. Then work out the number of weeds there would be in a given area, say 100 square yards. The greater quantity of weeds in the unspiked part will carry conviction as to the value of aeration.

Lawn aerating experiment.—Having counted the number of weeds as stated above, break up the squares, and examine the root systems of the various grasses forming them. It will be found that the grasses in the spiked part are much better provided with roots. This examination should be made ten months after the experiment is instituted.

Tomato experiment.—In the average packet of tomato seeds there are some seeds which show a green tinge. Others are smaller, and others again not of perfect shape. It can safely be assumed that seeds of this type are not as good as they might be. Eliminate them, and sort out for the experiment seeds of equal size, and as near perfect in outline as the eye can judge.

Grading onion seed.—In the average packet of onion seed there are three sizes. Before sowing, isolate each grade and sow separately. Note the results. The very small seeds will develop what is known as pin neck, that is to say, a contraction will appear early immediately above the bulb, preventing the latter from swelling to normal size. Many of the plants raised from the medium sized seed will develop thick neck, while those from the larger seed will form the biggest bulbs and there will be the minimum of the deformities so marked in the other two. This presents a clear case for the purchase of selected strains of seed, and the experiment shows that success is frequently governed by the contents of the seed packet.

GIRLS AND GARDENING

UNTIL a few years ago girls were entirely excluded from school gardening. The work was held to be too rough for them. That conception broke down, and quite rightly. Girls were allowed to participate in garden work in a modest way. It was almost pathetic to see the provision that was made for them. At most schools a few plots, about a yard square, were assigned to the girls. They cultivated simple flowers such as mignonette and virginia stocks. Doubtless they enjoyed this work, but it had little educational value.

From the very first this conception was doomed to failure. Now girls are allowed to go through the three year gardening course. As a rule they take their full share of all the operations. This is as it should be. A subject that is pruned for those who take it can never engage their full interest, nor can it possess the educational value it should. After girls reach the age of eleven years, and are eligible to attend senior schools, most of them are fully equipped physically for garden work, and should be allowed to do it. To differentiate, and say that girls might take flower culture only, is begging the question—so might boys. At schools where there are facilities for a full course, children of both sexes should take it.

The girls might go a little further and do some floral work, which develops their artistic qualities. They might, for example, have lessons in the cutting and arrangement of flowers. In connection with the former process, the first point to note is that no fully developed flower should be cut for vase decoration. Its life is too short, while the colour pigments rapidly decline. Always choose flowers that are about three parts developed. Never cut them when the sun blazes on them. Early morning and evening are the best periods.

Use sharp scissors or a knife. It is inadvisable to break off the flowers, because in so doing the intake of water is prevented, the cells at the base of the stems being sealed, or almost sealed. For twelve hours after cutting, plunge the stems into ice-cold water and keep the flowers in a cool, dry, airy room or cellar, where they will get what the professional florists call "their second wind;" in other words, they acquire a stamina that greatly lengthens their life.

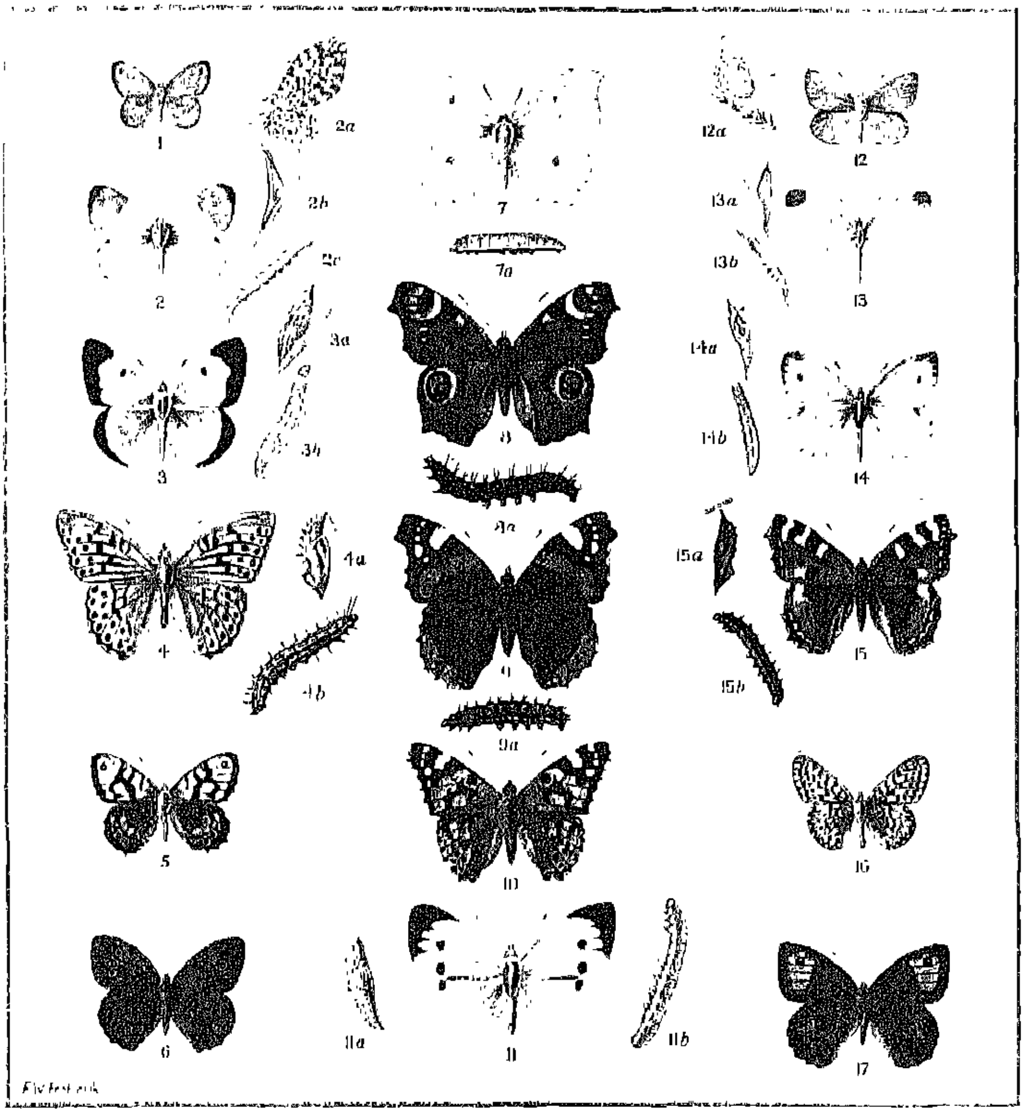
Before arranging the flowers permanently in the vases, crush the base of all woody stems such as lilacs and mock oranges with a hammer to increase the water absorptive capacity. Place one piece of nut charcoal in a vase of average size to prevent water pollution. Two aspirin tablets in a vase of average size are also efficacious. They are said to drug the slime fungus, which is the worst enemy of cut blooms. Stand the vases in a shady, cool place and change the water every second day.

When arranging flowers, avoid mixing orange and pink, pink and red, dull crimson and purple, and magenta with any other colour but white. Do not overcrowd the flowers in the vase. Every bloom should stand sufficiently on its own to display its true character. Consider carefully the length of stem. Short-stemmed flowers in a tall vase or épergne look ridiculous, as do long-stemmed flowers in a short vase.

While the vase of mixed flowers may look very well in a picture, it is not a success in real life. When flowers of different kinds are associated, one hastens the decay of the other. As far as possible, therefore, confine one kind of flower to each vase. Use fern or greenery with discretion. Maidenhair, Pteris, or Asplenium fern may be used with all flowers except roses, sweet peas, carnations and gladioli, which look far better with their own foliage.

SOME USEFUL CLASS PICTURES

BUTTERFLIES



BUTTERFLIES

(Class Picture No. 2 in the Portfolio)

1. Small Heath.
2. Orange Tip.
3. Clouded Yellow.
4. Silver-washed Fritillary.
5. Wall Brown.
6. Ringlet.
7. Brimstone.
8. Peacock.
9. Red Admiral.
10. Painted Lady.
11. Large Garden.
12. Common Blue.
13. Wood White.
14. Green-veined White.
15. Small Tortoiseshell.
16. Pearl-bordered Fritillary.
17. Meadow Brown.

Introduction.—Though it is not possible to generalise as to the differences between butterflies and moths, since exceptions can always be found, the distinctions given here hold for the majority of cases and will serve as a guide.

1. Butterflies are generally diurnal in their flight and feeding, whereas a great many moths fly at dusk or during the night.

2. The feelers or antennae of butterflies are slender, ending in a knob. In moths they are short, notched, distinctly pointed or feathered. They are not only organs of touch, but of smell. The sense of smell is very keen, and is the means by which the sexes find each other.

3. Butterflies usually rest with the wings folded above the body, edge to edge. Moths bring the wings to the level of the body, so that they form a flat triangle, not concealing its upper surface entirely. This is not, however, an infallible rule.

4. Moths have, on the whole, thicker bodies than butterflies. In butterflies the wings usually project backwards well beyond the body, but in moths the body may be longer.

5. Looper caterpillars all belong to moths. Very densely hairy ones usually do, so do very thick, fat ones. Usually, only moths make cocoons, that is, a separate outer covering of extraneous material, bound together with silk threads or some sticky secretion. This surrounds the pupa, which has its own protective skin in addition.

The wonderful colouring of both is due to minute scales covering the wings. These are modified, flattened hairs. The tubular proboscis, coiled like a watch spring when not in use, is characteristic of both, and is used for sucking nectar from flowers.

1. *SMALL HEATH.*—Pale brick, with narrow dark wing borders and small dark dot near front angle of fore-wing.

Caterpillar green, striped yellow and white, lives on meadow grasses. Meadows and heaths. Succession of broods from April to September.

2. *ORANGE TIP.*—Male, caterpillar and chrysalis. White, with orange tip to front wing in male only. Under side of hind wings marbled with green.

Caterpillar green, downy with black specks, on cress and cuckoo flower. Chrysalis greenish yellow and very slender. Common, fields and waysides.

3. *CLOUDED YELLOW.*—Male yellow, female cream, with black borders, and one black spot on each fore-wing. Hind wings deepen to an orange centre.

Caterpillar smooth green with yellow stripes and black dots; feeds on small leguminous plants such as trefoil. Chrysalis green with yellow lines. Eastern and southern counties, in the open.

4. *SILVER-WASHED FRITILLARY.*—Tawny orange, with black spots and streaks and delicate black scallop pattern on edge of wings. Gleams with silver.

Caterpillar brownish with long stiff bristles, feeds on dog violet, raspberry, nettle and guelder rose, but conceals itself by day. Chrysalis suspended on low plants, brownish with dark spots and stripes and light silver or gold spots on under-side. Woods. Widely distributed but not exactly common.

5. *WALL BROWN.*—Tawny brick or dull brown, boldly patterned with brown on fore-wings, small ring in front outer angle of fore-wing, hind wings have two curved bars of brick, outer patterned with small rings.

Caterpillar dark green, slightly striped white and yellow. Feeds on grasses, June and September. Chrysalis dark grey, with dorsal prominence.

6. *RINGLET.*—Dusky brown with three small black rings with pale centres on each fore-wing and two on each hind wing. Woodland glades, and bushes.

Caterpillar greyish with reddish down, and dark brown stripe along back, bordered by cream and white. Hibernates, then feeds on seeds and grasses till May or early June. Chrysalis on ground. Shaded brown, with bristles at hind end.

7. *BRIMSTONE.*—Butterfly and caterpillar. Sulphur colour, with an orange spot on each wing.

Caterpillar smooth bluish-green. Feeds on buckthorn. Chrysalis green with pale yellow stripes.

8. *PEACOCK.*—The name explains itself—colouring suggests eye in peacock's tail feathers. Red brick-orange ground, "eyes" in angles of wings in deep red, black, lilac and yellow. Fairly common in woods and lanes, and gardens, especially on Michaelmas daisies.

Caterpillar shining black with white dots and black spines. Feeds on nettle and sometimes hop. Chrysalis grey with metallic spots.

9. *RED ADMIRAL.*—A close relation of the Peacock, but instead of "eyes" has oblique bars on wings of brick, black and white, on brownish ground. Reddish-brick border to hind wings.

Caterpillar of same spiny type, but dull yellowish-green with yellow spines. Feeds on nettle in July—especially on seeds. Each caterpillar feeds singly, protected by a nettle-leaf drawn round it and caught together by a silk thread. Chrysalis greyish-brown with a few metallic spots.

10. *PAINTED LADY.*—Wings mottled pale brick on dark (nearly black) ground. Body and base of wings light brown. In August on waste ground, sitting in the sun on flowers.

Caterpillars dark grey with interrupted yellow stripe and short spines. Feeds singly in rolled-up leaves, nettle, mallow and others. Chrysalis brown with light spots and shining golden spots.

11. *LARGE GARDEN WHITE.*—Female, chrysalis and caterpillar. Butterfly creamy-white with black margin to fore-wings, and in female black spots. Yellow under-side.

Caterpillars pale cream and green, with black spots and sparse bristles. Chrysalis pale coloured, with powdering of fine gold dots characteristic of several other butterflies, which gives the name (*chrysos*—Gk. gold). Should properly be applied only to pupae of butterflies. Note also the spinous projections which hold a silk girdle in place, by which the chrysalis is suspended. Caterpillars feed on cabbages and other cruciferous plants, and garden nasturtium.

12. *COMMON BLUE.*—Male butterfly, and under-side. Blue suffused with violet. Under-side delicately spotted grey and tawny. Female brown. Heaths and open country, especially on chalk, but found in other places.

Caterpillar green and yellow, with black spines. Feeds on vetches and other low-growing plants.

13. *WOOD WHITE.*—Delicately veined white, with greyish tips to fore-wings. Weak flight. Shady places.

Caterpillar slender, smooth pale green, and pale, slender pupa. Caterpillar feeds on trefoil and vetch.

14. *GREEN-VEINED WHITE.*—Larger than garden white butterfly, with more strongly marked veins, and grey border to each fore-wing. A small grey spot in outer angle of each fore-wing, and near front edge of hind wing.

Caterpillar smooth green and white, pupa mottled light brown. Same food as garden white.

15. *SMALL TORTOISESHELL.*—Wings deep reddish-orange and brown with squarish spots of yellow, very dark brown, and white forming front border, and small blue crescents bordering the outer edge of the wings which are slightly notched.

Caterpillar and chrysalis dark, the former, which feeds on nettles, having short, sparse bristles and greenish-yellow longitudinal stripes. Closely resembles large tortoiseshell butterfly except in size, and in having darker bases to the fore-wings, but caterpillar of large tortoiseshell feeds on elm.

16. *PEARL-BORDERED FRITILLARY.*—Like a small edition of the silver-washed butterfly, but without the silver. Common in woods in May and June.

Caterpillar, which feeds on dog violet, is blackish, with bluish white dots and stripes, and yellow spines on the middle segments.

17. *MEADOW BROWN.* Dusky brown, with tawny patch on fore-wings, in which is a small black ring. Very common.

Caterpillar green, with darker dorsal stripe and cream-coloured lateral ones. Feeds on meadow grass.

MOTHS

1. *CINNABAR MOTH.*—About 1 in. across wing. Fore-wings dark grey with a scarlet stripe along the front margin, and two scarlet spots close to outer edge. Hind wings scarlet.

Caterpillar black and orange, feeds on ragwort, gregariously. Bright warning colours—inedible.

2. *HORNET CLEAR-WING.*—Remarkable for its resemblance to a hornet in form, size and colouring, yellow and brown striped, with clear wings bordered by a narrow light brown stripe.

3. *WOOD LEOPARD MOTH.*—A moth resembling a hawk-moth, but the wings are not so long or so pointed. (In the hawks the wings are at least twice the length of the body.) Grey body with black spots on thorax and delicate white wings spotted with grey.

Caterpillar white spotted with black, with black head, burrowing into and feeding on wood of many trees. Pale yellow with scaly black plates on first and last segments, and black spots on head. 2 to 3 in. long when full grown. Pupa large, smooth and brown.

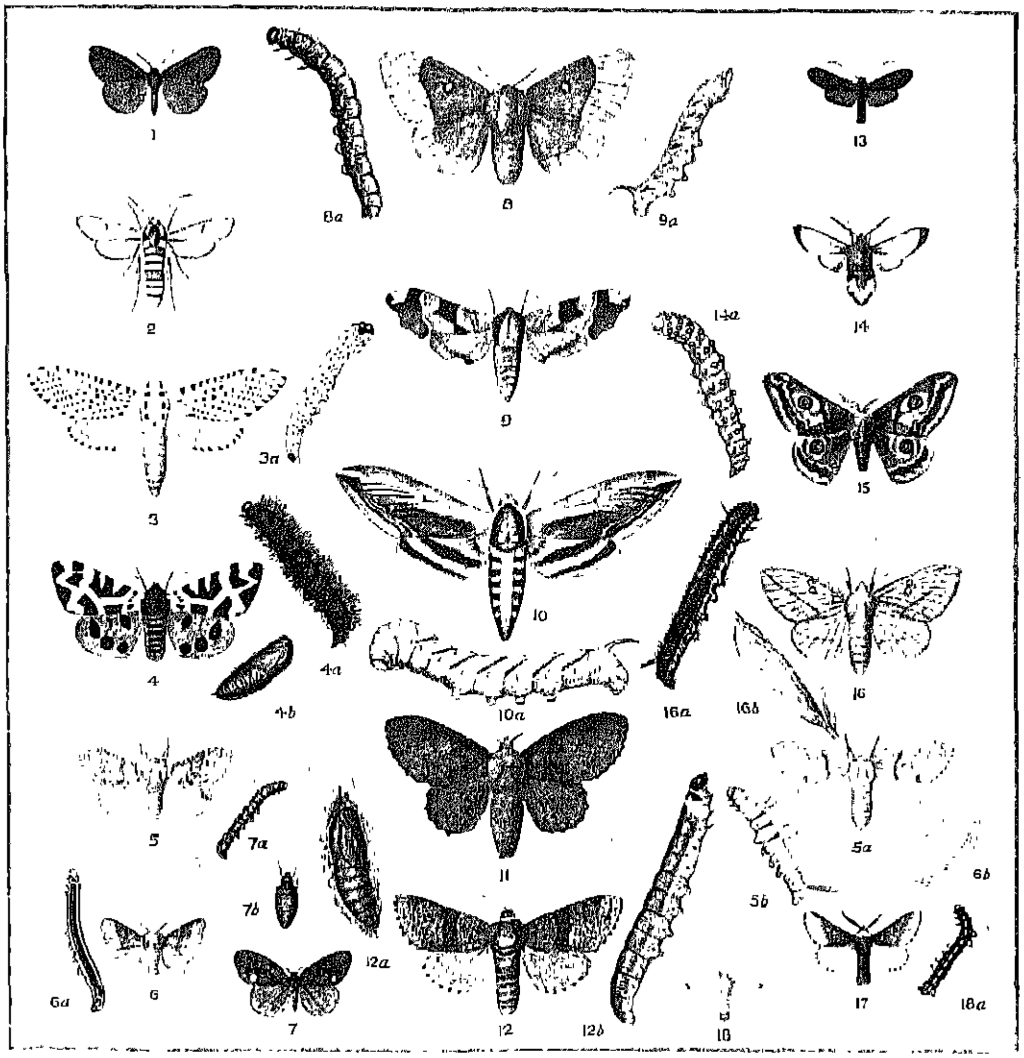
4. *COMMON TIGER MOTH.*—One of our most striking moths. Short thick body (about 1 in.) is brown and scarlet with dark bars across. Fore-wings, boldly patterned brown and white trellis-work, hind wings scarlet with almost black spots. Wing expanse about 2 in.

The caterpillar is the well-known "woolly bear," with a dark body covered with long brown and black hairs. These can be shot out if the caterpillar is alarmed, and can be very irritating and even cause a rash on the skin, hence children should be warned not to handle them. They walk very rapidly with a rippling movement. The pupa is glossy black, and is enclosed in an off-white, felt-like cocoon, in which most of the caterpillar's hairs, shed as it prepares to pupate, are entangled. Feeds on grass and herbage.

5. *PALE TUSSOCK MOTH.*—A soft looking, moderate sized moth with rounded wings and thick body. Fore-wings pale grey marked with darker wavy lines, hind wings lighter. The "tussocks" are bold tufts of yellow hairs decorating the first four abdominal segments of the grey caterpillar, which is slender and spotted with red. Wing span of moth under 2 in.

Caterpillar about 1 in. long, feeds on hazel, oak, poplar, fruit trees and hops.

6. *LACKEY MOTH.*—An inconspicuous light brown moth, about 1 in. across, with two pale wavy lines parallel to outer edges of fore-wings, dividing them into three equal zones.



Moths—I

(Class Picture No. 3 in the Portfolio)

1. Cinnabar Moth.
2. Hornet Clear-wing.
3. Wood Leopard Moth.
4. Common Tiger Moth.
5. Pale Tussock Moth.
6. Lackey Moth.
7. Vapourer Moth.
8. Oak Eggar.
9. Lime Hawk-moth.
10. Privet Hawk-moth.
11. Lappet Moth.
12. Goat Moth.
13. Broad-bordered Five-spot Burnet.
14. Narrow-bordered Bee Hawk-moth.
15. Emperor Moth.
16. Drinker Moth.
17. December Moth.
18. Gold-tail.

Caterpillar greyish, with bright orange-scarlet stripes extending the whole length of the body, separated by a white median dorsal stripe. Very injurious to the leaves of fruit trees. Gregarious, feeding and sheltering inside a silken tent.

7. *VAPOURER MOTH.*—The male is reddish brown with faint dark network on fore-wings, and white spot near outer margin. The female actually has a much larger body, but only vestiges of wings, so that it is inconspicuous.

Caterpillars grey, with orange and white hairs and tubercles, tufts of yellowish-brown hair (yellow in the *smaller* male caterpillars) and a pencil of black hair on first and eleventh, and two on sides of fourth segments. Very conspicuous and handsome. Destructive to leaves of many trees.

8. *OAK EGGAR.*—Both caterpillar and moth tawny brown. Large, thick-bodied moth with rounded wings and a ring on each fore-wing. Wings darker near body.

Caterpillar slightly hairy with white dots marking the breathing pores (spiracles).

9. *LIME HAWK-MOTH.*—All the hawk-moths have long, narrow, pointed wings, hind wings much smaller than front pair, and body ending in a point. Fore-wings of this moth olive-green with pale tips and with two broad bands of mauve-pink, one close to the body, the second nearer the edge and with a deep V indenting its inner margin. Body about 1 in. long, wings about 2½–3 in. expanse.

Caterpillar bright green with light orange spiracles and oblique lateral bands of yellow and red. A prominent curved spine or horn projects from the end of the body.

10. *PRIVET HAWK-MOTH.* — Larger than foregoing, brown, greyish-fawn and pink in colour; hind wings rosy. Wing expanse about 4 in.

Caterpillar of same type as in lime hawk-moth though larger, but with mauve instead of yellow and red stripes. Both named from food of caterpillar.

11. *LAPPET MOTH.*—Purplish-brown, the colour of young copper-beech leaves. A large moth with rounded, slightly toothed wings and thick body.

Caterpillar, which feeds on sloe and hawthorn, very large, with fleshy appendages or "lappets." Dark grey or brown, with long tufts of hairs at sides, and a very large black tuft on next to last segment.

12. *GOAT MOTH.*—Moth ashy grey, with rounded wings and thick body.

Caterpillar destructive, large, almost smooth, light chocolate-brown on back, pale yellowish-fawn below, with black head and spot behind head. Feeds in wood of trees like leopard moth, especially willow and poplar. Pupa golden to dark chocolate-brown, smooth, but with reflexed hooks, enclosed in a cocoon roughly made of chips of wood gummed together, and lined with silk. The hooks help it to escape from the tree. Name due to strong smell of caterpillar.

13. *BROAD-BORDERED FIVE-SPOT BURNET.*—A small moth with dark bluish-green fore-wings each with five scarlet spots, which however are usually confluent, making three apparently. Hind wings much smaller, scarlet edged with dark grey. Wing expanse about 1 in., wings narrow. Marshy places.

Caterpillar green with white and yellowish stripes, feeds on trefoil, vetch and other low plants.

14. *NARROW-BORDERED BEE HAWK-MOTH.*—At first sight closely resembles a bumblebee in size and shape of body and wings. Wings bordered with light brown. Mouth-parts and antennae, in both this moth and the hornet clearwing moth, would, however, at once indicate to an observer that these are moths, for they have the coiled "tongue" between short feathered "palps" or tasting organs, and the slightly feathered antennae of a moth. Flowery meadows near woods, in May. Quicker and more sudden flight than bees.

Caterpillar bluish-green with lighter marking, and white lines dotted with red. Scabious, honeysuckle.

15. *EMPEROR MOTH.*—The peacock eyes on all four wings are the distinguishing marks of this moth, which has purplish-brown front wings, and paler, more reddish hind wings. A dark bar extends along the

wings close to the outer edge. The short antennae are conspicuously plumed.

16. *DRINKER MOTH.*—Moth cream to tawny yellow ochre, downy. Wing expanse about 2 in.

Caterpillar rather resembles a "woolly bear" at first glance, but the hairs are not so long, the general impression of the colour is light brown, due to the hairs, though the body is slaty-blue. Two pencils or tufts of light hairs project from the back, one near the front and one near the hind end of the body. A light-coloured, silken cocoon is made.

17. *DECEMBER MOTH.*—A softly-coloured moth with brown body and lighter grey wings. Wing expanse about 1¼ in. Hind wings lighter than front. Narrow yellowish-buff stripes parallel to outer edge of wings. Appears October-December.

Caterpillar feeds on trees, and is gaily coloured with white and red spots, broken orange stripes, and black and grey hairs.

18. *GOLD-TAIL.*—White with abdomen tipped gold. About 1 in. wing-span.

Caterpillar brightly-coloured on black, with delicate tufts of long hairs on fourth and eleventh segments. A broken white median line along the back separates two broken red bands bordered with black. Feeds on fruit trees and others.

19. *LARGE WHITE PLUME MOTH.*—Actually only a small moth, though the largest of the "plumes." Each wing is divided into narrow segments, so that there appear to be five white plumes on each side of the body. Legs also long, delicate and trailing, adding to feathery effect. Very dainty little moths.

20. *EARLY GREY MOTH.*—Pale grey with yellowish hind wings and a row of dark pear-shaped spots bordering fore-wings. 1¼ in. across wings. Appears March–April.

Caterpillar feeds on honeysuckle, but hides during day.

21. *COMMON YELLOW UNDER-WING.*—Brownish-grey to dark brown, with body projecting well behind wings. Hind or under wings bright yellow ochre with black marginal bands. About 2 in.

22. *CABBAGE MOTH.*—An inconspicuous greyish moth with yellowish markings. 1½ in.

Caterpillar smooth, green or greyish, with faint oblique stripes on sides.

23. *SWALLOW-TAILED MOTH.*—Pale yellow, with hind wings drawn out into points.

Caterpillar well-known because of its resemblance to a small leafless twig, slender, stiff, and dull brownish-grey. Various trees and bushes; e.g., sloe, elder, honeysuckle. Caterpillar hibernates.

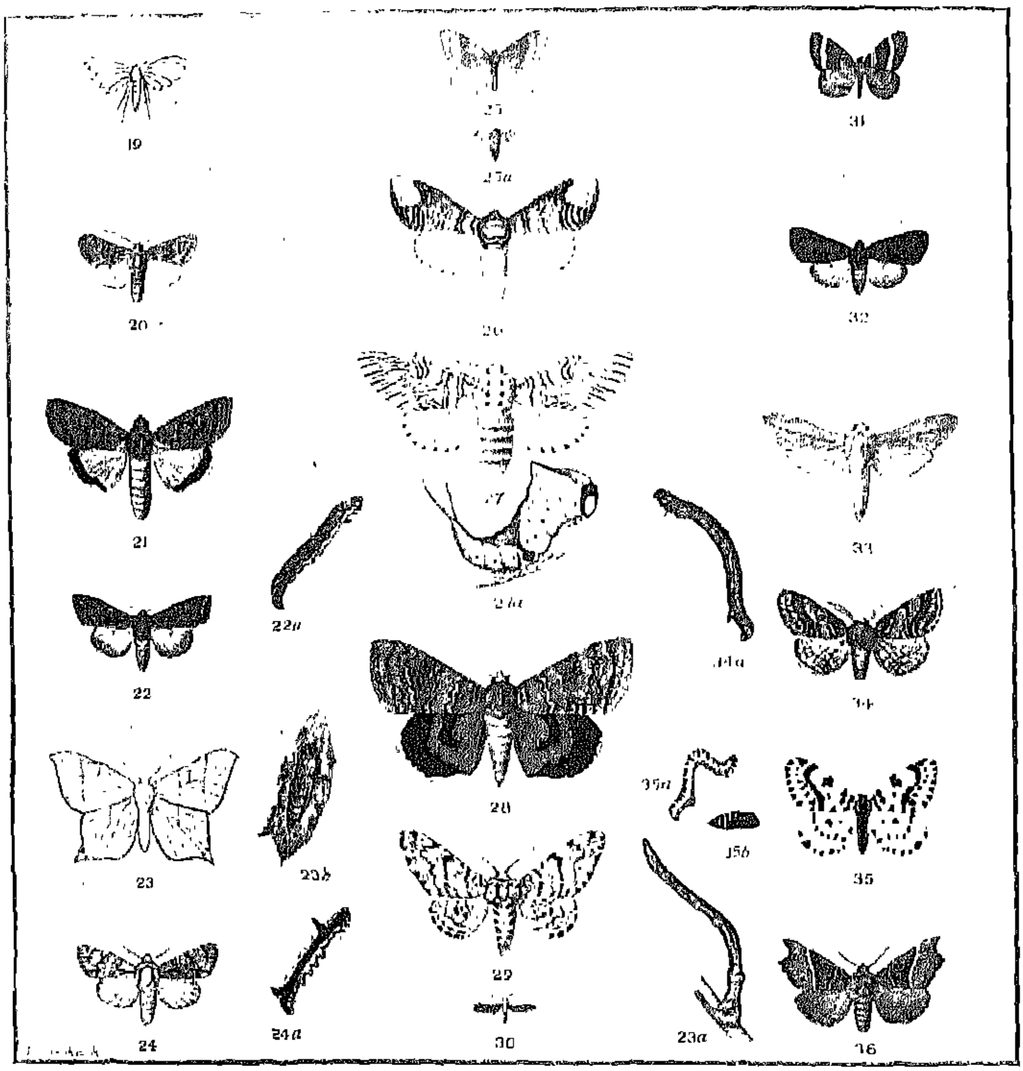
24. *GREY DAGGER MOTH.*—A pale grey moth, fore-wings darker, with grey marks pointing from edge to body, something like daggers with very wide cross-pieces.

Caterpillar on fruit trees and others.

25. *WINTER MOTH.*—Destructive to fruit trees. Light fawn with slightly darker shading. Female has only vestiges of wings, and has to crawl up to lay eggs, hence the use of grease-bands, but it is said that males have been known to carry females and so defeat the object of the band. Eggs laid on trees in late autumn hatch in March.

Caterpillars feed on leaves. They are green or brown, with a dark line along the back, and three whitish ones on each side.

26. *BUFF TIP MOTH.*—Front wings pale grey with dark wavy streaks and prominent yellow-buff tips. Hind wings and hind part of body cream; front part buff and orange. Wing expanse 2¼–2½ in.



MOTHS—2

(Class Picture No. 4 in the Portfolio)

19. Large White Plume Moth.
20. Early Grey Moth.
21. Common Yellow Underwing.
22. Cabbage Moth.
23. Swallow-tailed Moth.
24. Grey Dagger Moth.
25. Winter Moth.
26. Buff Tip.
27. Puss Moth.
28. Red Underwing.
29. Pepper and Salt Moth.
30. Common Ermine Moth.
31. Common Carpet Moth.
32. Dark Brocade Moth.
33. Common Shark Moth.
34. Brindled Beauty Moth.
35. Common Magpie Moth.
36. Herald Moth.

27. *PUSS MOTH*.—Large, pale grey, downy, with darker spots and streaks.

Caterpillar unique: large thorax broadens to a peak on dorsal side of abdomen, which then narrows to a point adorned with two streamers. Under parts bright green, dorsal parts grey. A broad pigment patch spreads over front part of body, and laterally into a "saddle." A bright red and orange "face" is really the front part of the thorax. The curious form, "face," and terrorising attitude adopted are said to be a protection against the enemies of this quite harmless creature.

28. *RED UNDERWING.*—A large moth (3–3½ in.) with wings extending to level of end of body. Fore-wings grey, with wavy dark lines, hind wings vivid crimson with broad black border and narrower curved black inner band.

29. *PEPPER AND SALT MOTH.*—Handsome dark and light grey moth, with distinctive wavy markings all over wings, fairly equally distributed and evenly patterned.

30. *COMMON ERMINE MOTH.*—Small, slender, with narrow wings which lie very close to body when at rest. Fore-wings white, finely dotted with black. Hind wings fawn or greyish.

Caterpillars are responsible for webs often covering privet and other bushes, inside which they live gregariously while they strip the leaves. There are several slightly different ermine moths.

31. *COMMON CARPET MOTH.*—A slender grey and brown moth, about 1 in., marked with fine dark lines parallel to edge of wings, and one white bar on the fore-wings. Suggests some of the old-fashioned Brussels carpet patterns.

32. *DARK BROCADE MOTH.*—Short body. Front wings dusky brown, with darker spot, almost square, near hind margin and zigzag line bordering margin, and other dark markings, all edged with yellowish-fawn. Hind wings grey, shaded darker.

33. *COMMON SHARK MOTH.* — In shape rather like the hawk moths—long, pointed body and pointed grey fore-wings, with much smaller, clearly veined yellowish-grey hind wings. About 2 in.

34. *BRINDLED BEAUTY.*—Brown and grey, with brindled markings; i.e., faint spots and well-marked dark lines, following the shape of the wings. Short body. Female paler.

Caterpillar a "looper" or "geometer" (earth-measurer) reddish-brown and purplish-brown, striped longitudinally, the stripes separated by fine black lines, small yellow spots on back, and narrow yellow band behind head. Feeds on oak, birch and other trees, including fruit trees. Very plentiful in London squares.

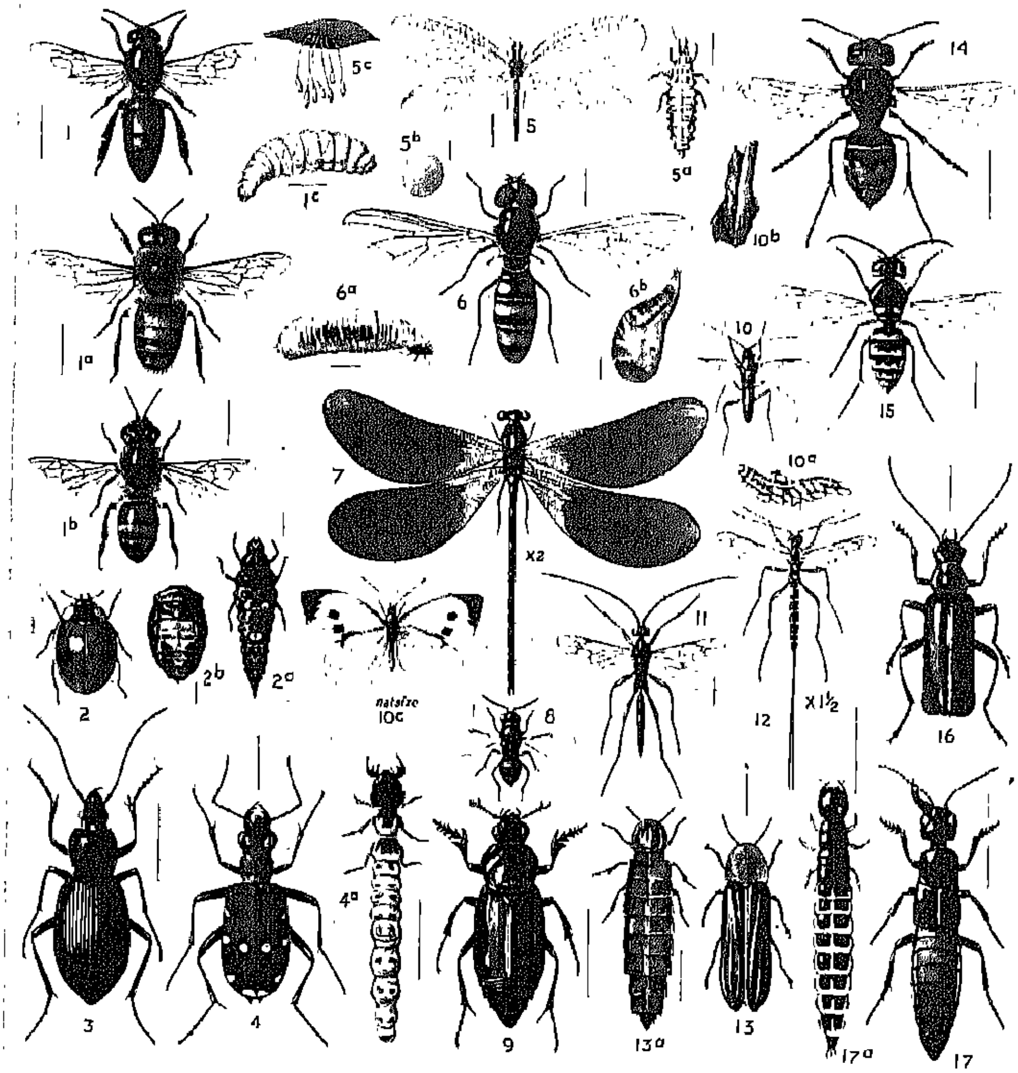
35. *MAGPIE MOTH.*—Also called currant or gooseberry moth. One of the best known to gardeners for the depredations of the caterpillar on fruit bushes, and on the ornamental evergreen *Japanese euonymus.* Moth cream, with black and yellow spots and streaks, very variable in quantity and depth of colour.

Caterpillar same colouring, black spots on back and yellow longitudinal stripe above legs on each side. Swings from twig to twig on fine thread. Pupa shining black with yellow bands—no cocoon.

36. *HERALD MOTH.*—Fore-wings reddish-grey to reddish-flesh colour at margin, with a broad triangular reddish-orange band, narrowing to the thorax, and marked with light and dark grey and orange and white dots, the colouring and design faintly suggesting a herald's garb. Margin, deeply notched behind front angle. Hind wings pale grey. On the wing in August and September. Hibernates and then reappears from March to June, and is common.

Caterpillar green and velvety, striped dark green, and yellow or white. Feeds on willow and poplar,

HELPFUL INSECTS



HELPFUL INSECTS

(Class Picture No. 13 in the Portfolio)

1. Honey Bee.
2. Ladybird.
3. Ground Beetle.
4. Green Tiger Beetle.
5. Lace-wing Fly.
6. Hover Fly.
7. Dragonfly.
8. Chalcid Fly.
9. Burying Beetle.
10. Braconid Fly.
11. Ichneumon Fly.
12. Ichneumon.
13. Glow Worm.
14. Hornet.
15. Wasp.
16. "Soldiers and Sailors,
17. Devil's Coach Horse.

The insects in these two plates (Class Pictures Nos. 13 and 14), helpful and harmful to man, have been chosen to illustrate the very wide range of habit, size and type of insects which come into contact with man's life. There are hundreds, even of British insects, which may do harm; a smaller number may be regarded as helpful, chiefly because they keep down the injurious forms by feeding on them.

1. *HONEY BEE*.—Worker, queen, drone and larva. Honey bees or hive bees have a highly organised society: the queen concentrates on egg laying, while the workers perform all other duties of the hive—gather pollen and nectar for bee bread and honey, make wax by means of glands in the abdomen, model the cells which make the comb, clean and attend to the larvae. Incidentally, in collecting honey and pollen, they bring about cross-pollination of flowers, securing the vigour of stocks and, in many cases, the survival of the breed, since many flowers can receive pollen only from other flowers. Apart from cereals, the greater part of all our crops depends upon the activity of bees to produce their seed, though it is true that other insects help.

2. *LADYBIRD*.—Adult, larva and pupa. Many distinct species of this small beetle exist. All, both as larvae and adults, feed upon aphides (green fly and allies). Larva black with yellow spots. Moults skin several times, then changes into short, thick, black and yellow pupa, which is quiescent for some time. Finally adult beetle emerges. Hibernates under loose bark or amongst evergreens such as box, often large numbers together.

3. *GROUND BEETLE*.—These beetles run about the ground and have lost the power of flight which most beetles possess. They are carnivorous, both in the larval and adult stage, and thus rid the soil of many noxious insects, slugs and snails. They have thread-like antennae. (The form of antennae is used in classifying beetles.)

It will be seen from these short descriptions that many beetles are of great value to farmers and gardeners. Others are, however, injurious to crops. It is therefore of importance to be able to distinguish as many as possible, both in the larval stage and the adult. The larvae of beetles are long and segmented, with sharp, curved jaws for biting, and a flat head. They may be active, if they are carnivorous, or very sluggish and inactive if they need only to crawl slowly in search of plant food, but not all active larvae are beneficial or vice versa.

4. *GREEN TIGER BEETLE*.—Both stages feed on insects voraciously, the adult roaming in search of them, but the larva digging itself a pit, or burrow, which may be a foot deep, and waiting at the top for its victims, which it draws into the burrow to devour. Note the bent form of the larva, the broad, hard head (said to be used like a bricklayer's hod, for carrying earth up from the burrow and throwing it out) and the hooks on the abdomen which seem to help it to grip the sides of the burrow, like the earthworm's bristles. The adult has threadlike " horns " and a rather rectangular body.

5. *LACE-WING FLY*.—Fly, larva and pupa, and eggs attached to a lime leaf by slender stalks. Adult transparent, and eggs so small that they are often overlooked, though fairly common. Greenish, with golden eyes. Four wings. Attracted by lights to houses, like moths. Larvae light brown, bristly, and often covered with remains of skins of aphides they have eaten, for like the ladybirds, lace-wing larvae and adults feed on these.

6. *HOVER FLY*.—There are several different kinds of hover fly. The one illustrated is banded with black and yellow, the warning colours usually associated with a sting. They have no sting, however; this is sup-

posed to be a case of protective mimicry, for, though they do not resemble any wasp or bee very closely, the colours might perhaps suggest to birds that they are dangerous. They differ from wasps and bees in having only one pair of wings, and in not having the abdomen constricted just behind the thorax to form a "waist." The hovering movement is produced by very quick beating of the wings, enabling them to stay in one position for several seconds. The adults feed on pollen, and are particularly fond of Michaelmas daisies, over which many of them may be seen on sunny autumn days. They help in fertilising flowers, but their great service to man is performed by the larvae, which feed voraciously on green fly and other aphides. The larva (grub or maggot) has a large, swollen, almost transparent body and small head, so that it suggests a sack being dragged along by a dwarf. The pupa might be mistaken for a very small slug, greyish-brown in colour and lightly striped, usually in a humped-up position between leaves. Both maggots and pupae may hibernate amongst dead leaves. It is said that one larva will kill nearly one thousand aphides during that stage of its life.

7. *DRAGONFLY.*—The dragonfly figured here is *Callopteryx sp.* Like all the dragonflies, in the adult stage this insect feeds on the wing, on flies chiefly, and therefore helps to keep down the numbers of these injurious insects, many of them disease carriers. It is important to realise that dragonflies are in themselves harmless as well as valuable, because many are killed under the impression, according to an old superstition, that they are "horse-stingers." They have no sting.

8. *CHALCID FLY.*—These are minute parasitic insects, closely related to the ichneumons and having similar habits, but all are minute. There are many of them; some attack wasps, some moths, and a few attack plants. Frequently they are of brilliant metallic colouring. They are mentioned here in order to draw attention to the fact that very minute insects *may* be useful, and should therefore not be killed without further inquiry. The one figured, *Encassia formosa*, attacks and controls greenhouse white fly, and is therefore of great value to nursery gardeners.

9. *BURYING BEETLE.*—A useful scavenger, helping to bury the bodies of rats, mice, birds, and other small animals, upon which it feeds after digging away the ground from under them until they sink and are covered by the soil. Incidentally, the parts which the beetles do *not* devour, eventually enrich the soil with nitrates. There are many different burying beetles. Club horned.

10. *BRACONID FLY.*—These again are minute forms related to the *Chalcids* and *Ichneumons*, and of similar habit. The one figured is common as a parasite on the cabbage white caterpillar and therefore helps to control this pest. Its larva lives inside the caterpillar, emerging to pupate when the caterpillar also is just ready for pupation, having kept pace with it. Note the wonderful thing which keeps the caterpillar alive as long as the braconid needs it. The pupae are enclosed in small, cylindrical cocoons of yellow silk, about 1 in. long. The "flies" are black, and waisted. Another braconid is fairly common as a parasite inside magpie moth caterpillars, and causes a distorted barrel-shaped black and white (instead of black and yellow) pupa to be formed, from which no moth emerges. As this moth destroys the leaves of currants and gooseberries, its parasite may also be regarded as useful to man.

11. *ICHNEUMON FLY.*—There are many ichneumon flies, some very small, some large. They belong to the same order of insects as the bees and wasps, and have four wings and a narrow waist. Their general habit is to lay eggs inside the body of some other insect,

in the larval stage or even in the egg; the grub lives parasitically, keeping pace with its host, and eventually kills it, when the parasite is ready to pupate. The ichneumon figured is a species of *Rhyssa*, which attacks the larva of one of the wood-boring wasps, *Sirex*. Since these larvae cause very great damage to pine wood, the parasite Rhyssa is of assistance to the owners of forest trees in helping to keep down their numbers. The adult female Rhyssa searches over the surface of a tree trunk, and in some way (possibly by smell) detects the presence, deep inside, of a Sirex grub. She then bores down with her needlelike ovipositor (egg tube) and deposits an egg close up to the grub. The egg hatches and lives, in this case, as an *external* parasite on the Sirex, eventually killing it.

12. *ICHNEUMON* (*Limneria gracilis*).—This lays its eggs on the larvae of the diamond back moth which attacks turnips, and is therefore useful in checking its spread.

13. *GLOW WORM*.—Male and female. These are chiefly known because the female beetle carries a light to attract the plain brown males, but they are useful because the larvae feed on small snails. The adult beetle is only about ⅓ in. long, with serrate (saw edged) "horns." Under the tip of the abdomen the female (and to a very slight extent the male) produces a phosphorescent substance which gives a bright, soft greenish light (very like the "daylight" lamps seen at a distance). Active at night on damp, grassy banks, especially on still, warm nights from early dusk onwards. The light is intermittent.

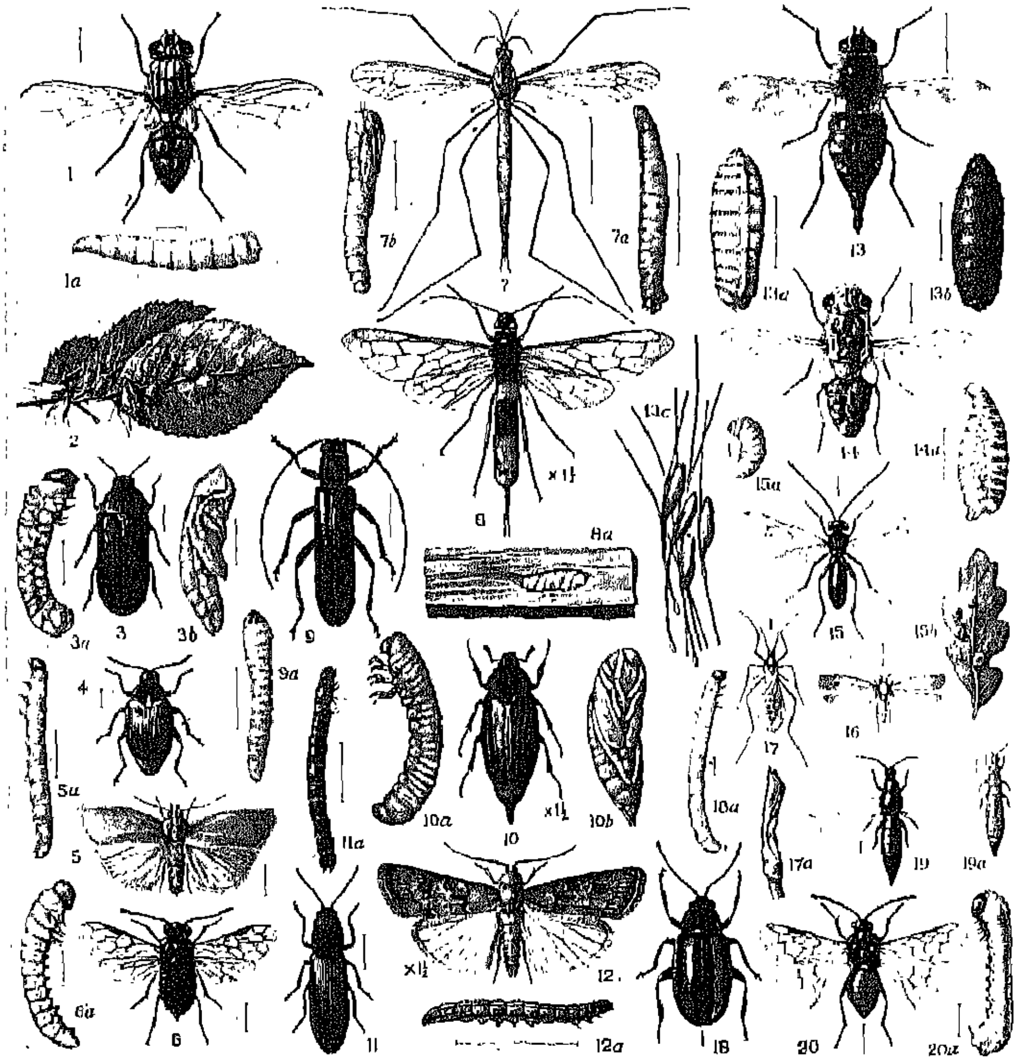
14. *HORNET*.—Of similar habits to the wasp, the hornet is much larger, handsomer, and at the same time more terrifying in appearance. Its sting can be dangerous, but undoubtedly on the whole, like the common wasp, it is valuable in keeping down caterpillars which would injure crops.

15. *WASP*.—The common wasp is not generally held in high regard, but there is no doubt that it pays its way by killing large numbers of caterpillars. It is true that wasps take heavy toll of fruit, especially plums, but doubtful if they can gain entrance to perfectly sound fruit. Usually they feed on fruit which has been pecked by birds. However, their usefulness depends on their numbers being strictly limited and they may easily pass the point where it ends, in seasons which are favourable to them. Caterpillars and other insects are stored as food for the larvae.

16. *"SOLDIERS AND SAILORS."*—Bright red and blue ground-dwelling beetles feeding on larvae, slugs, earthworms.

17. *DEVIL'S COACH HORSE*.—Another carnivorous beetle which helps to keep down insects in the soil. When it is realised how many insects which attack plants (such as the turnip fly) spend part of their time in soil, or lay their eggs in it, it will be understood that the various carnivorous beetles are of high value to the gardener and farmer. Another name for the devil's coach horse is the rove beetle from its roving habits. It is rather primitive, and its narrow shape suggests a larva rather than an adult beetle, especially as the very short wing cases (*elytra*) expose more of the body than is usual and so show the segmentation. The abdomen is supple, and frequently tilted up, thus giving it yet another popular name, the cock-tail beetle. It is dull, sooty black, and very jaunty-looking. Its "horns" or antennae are clubbed. The underground larva is not nearly so frequently seen as the adult.

HARMFUL INSECTS



Harmful Insects

(Class Picture No. 14 in the Portfolio)

1. House Fly.
2. Aphis or Green Fly.
3. Deathwatch Beetle.
4. Pea Weevil or Red-footed Beetle.
5. Green Oak Moth.
6. Apple Sawfly.
7. Daddy-long-legs or Crane Fly.
8. Wood Wasp.
9. Poplar Weevil.
10. Cockchafer.
11. Click Beetle.
12. "Cutworm" or Turnip Moth.
13. Botfly.
14. Gadfly or Warble.
15. Gall Wasp.
16. Clothes Moth.
17. Hessian Fly.
18. Turnip "Flea."
19. Pea and Bean Thrips.
20. Turnip Sawfly.

Of the injurious insects, many are very minute, rendering them difficult to detect. Many spend the pupal or resting stage of their life in hiding, and in this condition are carried to new situations, for instance in dead leaves, straw, or soil. Generally, insects can hardly be regarded as serious pests unless they occur in large numbers, so that in some years they may be comparatively harmless—green fly, caterpillars and sawflies—depending on the weather and other conditions. Some insects, however, are to be feared if they make their appearance because they will inevitably multiply, spread and do serious damage—the dangerous Colorado beetle which attacks potatoes, is an example, which must be notified to the Ministry of Agriculture in the same way as dangerous human diseases must be notified.

Every order of insects contributes to the list of those which may be dangerous, but Coleoptera (beetles), Hymenoptera (sawflies and gall midges), Lepidoptera (butterflies and moths), and Diptera (two-winged flies) probably contain the largest number of man's enemies.

In the Class Picture the small lines indicate the actual sizes of the grubs.

1. *HOUSE FLY.*—Belongs to the *Diptera*, or two-winged flies, which have the second pair of wings reduced to knobs, yet have a very highly developed power of flight and of balancing. Members of the order have very varied feeding habits, some sucking nectar (e.g., hover flies), some sucking the blood of animals (e.g., stable flies, gadflies, tsetse fly), many living on carrion and refuse. They all have short, awl-shaped larvae or maggots, with no legs or eyes, usually finding their food by smell. In the house fly these are white. The eggs are laid in damp dust and refuse, and hatch out as larvae in about two days, and in six or seven days, complete their feeding, having shed their skin twice, and pass into the pupal stage. The pupa is a small, oval, darkish brown body which might be mistaken for some kind of seed. A number of these are usually found together. In warm weather the flies develop in a few days inside the pupal skin and emerge, to lay another batch of a hundred or more eggs.

The adult flies possess a small pump by which they suck up food. If they alight on bread, sugar or other solid food they emit saliva, which dissolves, or partially digests, the food, turning it into liquid.

The danger to human beings lies in the proved fact that flies are very likely to carry disease germs on their feet. The feet are provided with pads, covered with bristles, by means of which they can cling to almost any surface; for a smooth, slippery surface the bristles exude a sort of glue. As the flies frequent all sorts of dirty places when decay is taking place, in search of food, they may pick up the germs of diarrhoea types of disease, and convey them to food direct or to the rims of milk bottles and jugs, dishes and so on, from which contamination can spread.

The best preventive measure is to keep flies down by scrupulous cleanliness, thus allowing no breeding places, and by keeping all food carefully covered and inaccessible. Especially, the lids of dust bins should fit securely and should always be in place, and bins should be renewed whenever any cracks appear which might admit flies. Frequent emptying and disinfection are in the public interest.

The common house fly may be recognised by its dark ash-coloured body with black stripes down the thorax and one on the abdomen. It does not bite or sting, but several other fairly common forms do.

2. *APHIS or GREEN FLY.*—There are many aphides, some green, some black, some woolly, all causing what are known as blights, that is, they multiply so rapidly in warm weather, especially where rapid growth of young shoots has rendered them vulnerable, that in a few days they cover huge surfaces and cause serious injury. They pierce the skin of leaves and stems, near the tips of young shoots particularly, and

suck the sap. Many kinds secrete a sticky, waxy juice (e.g., on sycamore and lime) which makes the leaves very unpleasant to touch and possibly interferes with their function by clogging the pores. The proboscis is a short, sharp piercing tube, capable of suction.

Eggs hatching in the spring from a batch laid in the autumn, develop in a few hours into wingless adults, feeding actively. From the end of the body they produce on an average two similar offspring a day and these in their turn go on multiplying at the same rate under favourable conditions. This might continue throughout the summer, but many checks supervene, especially falls in temperature or heavy rain. Fortunately, too, the green fly has many enemies (as described under **Helpful Insects**).

This type of reproduction takes place without any male forms being needed, that is, these females produce unfertilised eggs which hatch out. From time to time, especially if food is getting scarce, a few winged females appear, which migrate to new pastures, and so extend the "blight." They do not reproduce their kind so rapidly as the wingless forms, and have a more gradual growth, often protecting themselves by a silken web. Some aphides curl up leaves to protect themselves.

In the autumn, wingless females and winged males appear, which unite to produce fertilised eggs, and it is these eggs that survive the winter.

Thus, the rule is, rapid production of summer broods from unfertilised eggs under favourable conditions, but slower production of smaller numbers of fertilised eggs, to make sure of survival under the adverse conditions of winter. These eggs are laid amongst the bud scales, and as soon as the buds open in the spring, the eggs hatch and begin to feed on the tender growth.

3. *DEATHWATCH BEETLE.*— The deathwatch beetle and the furniture beetle are closely related. In each case, it is the burrowing of the larva that causes serious injury to wood. They have a marvellous power of digesting wood and obtaining nourishment from it. The small, wormlike white larvae have hard biting jaws, and as they tunnel they push behind them the sawdust or "frass" which falls out as powder and betrays their presence. The tunnels destroy the wood, often rendering structural beams and floors dangerous by serious weakening. After two or three years the larvae pupate, then the adult beetles emerge. These are small dull brown creatures about $\frac{1}{8}$ in. long. They come out of the wood, and lay eggs in surface crevices, from which the young larvae start making new burrows. The mature beetles then die. Expert help is needed in exterminating them, but a copper preparation is now on the market which is effective in destroying the furniture "worm."

4. *PEAWEEVIL or RED-FOOTED BEETLE.*—Although popularly called a weevil, this is again not technically correct, and is better called the pea beetle. It is dark-coloured with red *feet* (first two pairs), while the nearly related bean beetle has red *legs*. It also has dark spots on the pale exposed tip of the abdomen. It eats away the inside of the seeds, and if the "germ" is eaten, they cannot, of course, grow. The conspicuous round holes which they make in leaving the seeds are well-known. The eggs are laid in the flower, and the young larva at once enters the pod, then a developing seed. Here it feeds, until it is ready to pupate, when it bites a hole almost to the surface, leaving a thin skin. Pupation takes place in the seed, and the mature beetle bites its way out. Apparently the infection comes from foreign-grown seed and the beetles do not seem able to persist in England long enough to establish themselves as a regular pest.

5. *GREEN OAK MOTH or GREEN TORTRIX.*—Is one of the common moths whose caterpillars suspend themselves by threads from oak leaves, frequently swinging against the faces of passers-by. The moth,

which is green and grey, with fringed wings, emerges in May, and lays eggs on oak leaves. The caterpillars, green with black raised spots, do much damage, often stripping the trees. They pupate in rolled-up leaves.

6. *APPLE SAWFLY.*—The sawflies belong to the same order as bees, wasps and ichneumon flies. By means of a sawlike apparatus connected with the egg-laying tube, the females cut holes into which they drop their eggs. The larva which hatches looks like a caterpillar and behaves like one, but it has six to eight pairs of "prolegs" on the abdomen, whereas caterpillars have never more than five pairs; i.e., the first two segments of the abdomen do not have them.

The eggs of the apple sawfly are laid in the blossom, the larva hatches and bores into the young fruit and eventually brings it down. The grubs, when fully fed, eat their way out and pupate in the soil round the tree, so that the best treatment is to bury the top two or three inches of soil deeply, or burn it on a bonfire, thus preventing the flies from emerging. The trees may be sprayed in April with paraffin emulsion (1 wineglassful to 3 of soft soap in 3 gallons water).

7. *DADDY-LONG-LEGS or CRANE FLY.*—The two-winged fly needs no description, though attention may be drawn to the long projections (halteres) behind the wings, which represent the lost second pair. The male has a thick, pointed abdomen; in the female it is more slender, ending in a pair of projections whose purpose is to hold each egg as it emerges and push it into the soil. From two hundred to three hundred eggs are laid separately. The legless larvae or leatherjackets have strong biting jaws, with which they feed on the roots of grasses, including corn, doing serious damage. Golf courses and a year or two ago Lord's cricket ground, have been ruined by them. The remedy where large numbers exist, is to cover the ground with rubber sheeting and flood it under this with water, thus drowning them. Birds, for instance rooks, destroy a great many. They are dull greyish-brown, or earth colour, and thus difficult to detect, especially when small. They reach a length of about 1 in.

8. *WOOD WASP* (*Sirex*).—Causes injury to fir trees in the same way as the furniture and deathwatch beetles in other wood, by boring tunnels, in its larval stage, and feeding on the wood. These tunnels are, however, much wider as this is a bigger creature. It is interesting to notice that insects of very different types may have similar habits. The wood wasp is more like a sawfly than an ordinary wasp, having no "waist," but its colouring is like a wasp. A long boring instrument projects from the abdomen, giving it the name of *horntail*.

9. *POPLAR WEEVIL.*—Quite often the name "weevil" is given popularly to beetles which are not true weevils. This is an instance, for it is one of the many Longhorn beetles whose soft, legless or almost legless grubs or larvae burrow in trees, destroying the wood. The word "weevil" seems to be derived from the same root as "weave" and is applied to many beetles which make a network of tunnels.

10. *COCKCHAFER.*—Both larva and adult of this beetle are highly injurious, the larvae feeding in the soil on roots, the adults biting the leaves of trees and often almost stripping the trees in years when they are numerous enough to be a pest. Sometimes called May bug, June bug, or dor beetle. They fly with a heavy flight, and swarms of them are sometimes at first mistaken for bumblebees. At close quarters they are seen to be nut-brown beetles with curious comblike feelers. The larva is white, soft, and very sluggish, with a brown hard head and strong jaws. It feeds in the soil for two years, pupates for a short time, but remains in the soil, as a beetle, through the next winter, emerging in May or June, when it is practically three years

old. The eggs are laid in holes dug 2 or 3 in. deep in the soil, in small clusters, and hatch in five to six weeks. The best way to get rid of cockchafers is by keeping a sharp look out for the larvae or brown pupae when digging. The larvae are like caterpillars, but have no abdominal legs. They always lie in a curled position.

11. *CLICK BEETLE.*—The larva is the well-known "wireworm," a slender, active, shining, yellowish creature which wriggles away as one digs. The eggs, laid under the soil in May to July, hatch into tiny whitish larvae, which change their skins many times as they grow, becoming deeper in colour each time. Powerful jaws can attack and kill other insects, though their usual food is the roots of all kinds of plants and underground stems, such as potatoes, which may be riddled by them. They feed for about five years before pupating in a burrow in the soil, and emerging as slender brown or blackish beetles.

Rough grassland is very often the original source of infection, so that careful cultivation is necessary when this is turned into garden or nursery beds. The turf should be deeply turned in, and the soil well rolled, a crop of potatoes or closely sown mustard will usually help to get rid of them. In small areas they may be trapped by burying potatoes or carrots through which a stake has been pushed, which protrudes above the soil. These may be lifted from time to time, when they will be found to have attracted many wireworms. It is best to break up weedy land or grassland in late summer, then take a crop of mustard, rape or other immune plants. A dressing of crude napthalene (3 oz. to sq. yd.) is often effective. Pupation takes place in late summer; a month or so later the beetle emerges, either to remain in the soil till the spring, or if disturbed, to wander away and seek refuge in dead leaves or other refuse.

12. " *CUTWORM* " *or TURNIP MOTH CATERPILLAR.*—Dingy-looking, fat caterpillars which cut through seedling plants just above the soil, as well as feeding on them below the ground. Often turned up when digging. They feed at night, hiding by day under dead leaves, soil or grass. The yellow underwing moth has a caterpillar of similar appearance and habits, and so has the heart and dart moth. Caterpillars are greyish or brownish, with black dots down the sides. Moths appear in June and again in August and September. The caterpillars may either feed rapidly, pupating in July to produce moths in August, or feed more slowly, not pupating until February to April, but passing the winter as caterpillars in the soil. The moth has greyish-brown front wings and white hind wings, front wings with dark markings.

13. *BOTFLY.*—A two-winged fly which lays its eggs on the hairs of the horse, which by licking them, both causes them to hatch, and swallow the small maggots, which are not however digested, but feed on the lining of the stomach. When fully fed they are passed out with the dung, bury themselves in the earth, and pupate. The flies are hairy and rather beelike, but with a short ovipositor projecting from the abdomen. The larva at first is club-shaped, with rings of small spines; hooks surrounding the mouth enable it to cling to the stomach lining. Later, the hinder end becomes greatly swollen into a barrel shape with food—this is the "bot."

14. *GADFLY or WARBLE.*—The fly lays eggs on the hairs of the legs of cattle, and the maggots bore through the skin of the legs and make their way through the tissues till they reach the wall of the gullet, where they remain in a resting condition for some months. They then take up their wanderings again till they are just under the skin of the back, through which they bore holes and escape, causing sores or "warbles" and ruining the hide. They bury themselves in the soil to pupate, then emerge as flies to lay eggs again.

15. *GALL WASPS.*—There are many gall wasps, minute black insects which pierce the tissues of plants by means of a sharp ovipositor, and insert their eggs. The larvae hatch and start feeding, setting up irritation which results in the formation of a blister or gall, inside which the larva lives. The marble gall and spangle gall on oak, and "Robin's pincushion" on rose trees, are examples. Each gall has its own characteristics, but there is usually a hollow cavity in which the larva lives, and a nutritive layer surrounding it, with a hard protective layer outside this, and then probably softer outer layers. They are usually distasteful to birds. When the soft, white, legless larva has grown to its full size it pupates inside the gall, and later the perfect insect bites its way out. Marble galls are frequently found late in the year, with the circular tunnel from which the wasp has escaped. They generally leave it in September or October, and lay eggs at the ends of branches or in the axils of leaves. These develop in the following year. Young galls are greenish, then yellow, and soft; they gradually darken and harden. They do not cause serious injury in most cases, unless they are present in great numbers; they are, of course, using some of the food supply of the plant.

16. *CLOTHES MOTH.*—There are two or three species of clothes moth, all very small, belonging to the genus *Tinea*. Eggs are laid in fur, feathers or woollen materials, and the larvae feed on their substance—another instance of marvellous digestion. The clothes moth or tapestry moth spins a web in which to conceal itself as it feeds, the woollen moth, perhaps commoner, makes a case of minute particles of the material, which is an even better concealment. They pupate inside their cases, usually in some hidden corner, and remain through the winter, emerging as moths from February onwards and giving rise to several broods in the season. They dislike cedar wood, so that a cedar lining to boxes and wardrobes is an efficient protection. Cedar wood oil, naphthalene, camphor, all help as preventives, but the best thing is a careful watch, taking out, shaking and airing furs and clothes and blankets frequently.

17. *HESSIAN FLY.*—A minute black fly whose larvae feed on the stems of wheat near the ground, lying just above a node, protected by the leaf sheath. The innermost leaf turns yellow, the first sign of the attack. The stem is weakened and easily "elbowed" when the ear becomes heavy. Results visible in July. Pupation occurs in the stubble or amongst hay carried away, and flies may emerge in the autumn, in which case they die before the English winter-sown wheat is above ground, or they may remain as pupae through winter and emerge in early summer, when they catch any spring-sown wheat. Much commoner for this reason in America, from which they were first introduced to England.

18. *TURNIP "FLEA."*—These are small beetles, not more than $\frac{1}{8}$ in. long, which eat the young leaves of members of the cabbage and turnip family (*Cruciferae*). Some are metallic blue and black, others have a yellow stripe on the black wing case. It is the adult beetle in this case that does the damage. They jump when disturbed. They spend the winter in hiding, especially in haystacks near turnip fields, and emerge when the first seedlings are barely out of the seed. At first they feed on any cruciferae, later they usually concentrate on turnips, swedes and cabbages, flying from crop to crop. Eggs are laid on the soil from end of May to September; young larvae either crawl up and burrow into leaves, or *down* into roots (different species behaving differently) where they live until they are ready to pupate, when they crawl into soil. In three weeks the beetles emerge. The irregular holes all over the seed leaves and first foliage leaves of seedlings betray their presence. Careful cultivation seems to be the best means of preventing their attacks, for it promotes

quick, healthy growth of the young plants, past the stage when they will be attacked. Heavy watering and spraying with soapy water and a little nicotine are recommended. Charlock seems to encourage them. Clearing away of all refuse which affords winter shelter will lessen the danger from this and many other pests, including parasitic fungi as well as insects.

19. *PEA AND BEAN THRIPS.*—Minute, slender, four-winged flies, about 1/16 in. long. Details can be seen only with a microscope but the narrow wings are fringed with hairs. The young are like the adult, but wingless. In the pea thrips the young are bright orange with a black tip. Eggs are laid in June in the stamen sheaths or very young pods. They hatch in 8–9 days, and the orange-coloured larvae begin to feed by scraping away the inside of the pod, leaving it thin, pale silvery, and mottled or patchy in appearance. Three or four weeks pass in feeding, and the young then find their way into the soil, where they pass the rest of their life history, spending the winter there and emerging in the spring. It is said that it is best to avoid cropping the same ground with peas again after an infection. This seems reasonable as the flies will emerge again from the soil in the next season. A nicotine and soft soap spray of the young pods, if infection is observed, is said to be effective. (The Ministry of Agriculture leaflet gives ¾ fluid oz. nicotine 95–98% to ½–1 lb. soft soap—according to hardness of water, and 10 gallons water.) N.B. *Very* important to keep nicotine under proper control as it is a *dangerous poison.*

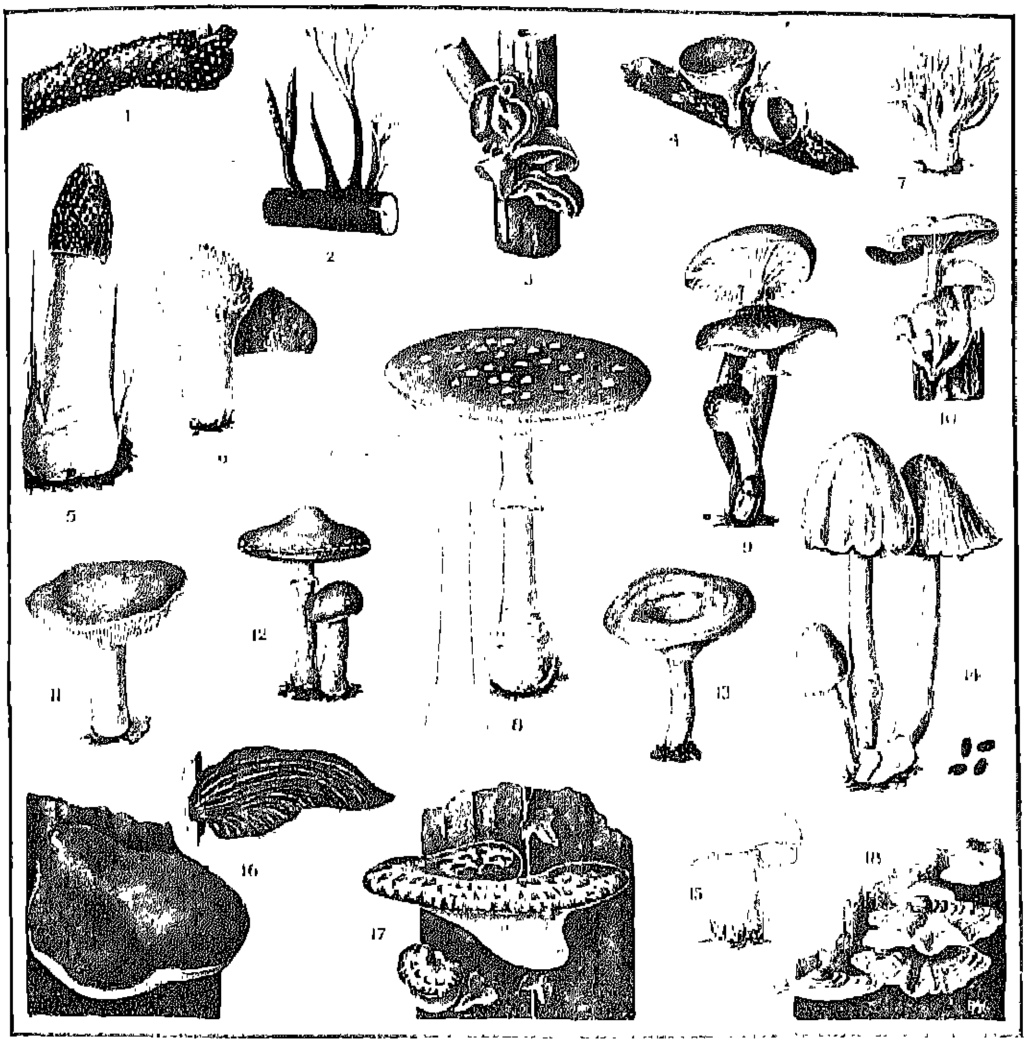
20. *TURNIP SAWFLY.*—Note the same general features as described for apple sawfly—small four-winged fly and many-legged grub, which lives inside the turnips. Eggs laid on leaves by cutting a hole with a pair of "saws," part of the egg-laying apparatus. The larva feeds on the leaves like a caterpillar, nibbling round the edge till all the soft tissue is eaten. Like a caterpillar, too, it curls up when disturbed, but it can be distinguished by its many legs.

COMMON FUNGI

1. *CORAL SPOT.*—The spore-bearing body or fructification of a fungus which penetrates twigs, branches and fences in damp situations, by means of white thread-like suckers which are able to obtain food from the wood. Practically all fungus plants are of this nature. The white threads are called hyphae; they form a network called a mycelium. The visible part only is generally known, but the mycelium is the permanent part of the plant. Coral spot is described by its name. It frequently attacks pea sticks and faggots stored for the winter, as well as dead branches lying on the floor of woods. It bears spores in pits all over the surface of the spots, which are raised.

2. *CANDLESNUFF.*—Usually found on tree stumps in damp, mossy and grassy places and floors of woods. It bears two kinds of spores; the white powder covering the tips is made up of hundreds of minute masses of protoplasm enclosed in hard walls, while the black lower part is covered by little pits, in each of which another type of spore is found.

3. *JEW'S EAR.*—A fructification which is like tough red indiarubber in texture and colour, with curious cavities and ridges moulded to a semblance of human ears—or more like the ears of apes. A yellowish-pink to dull brown. In the young stage these are rounded lumps; the compression and hollows appear later. About 2–3 in. when fully grown. Only found on elder.



COMMON FUNGI

(Class Picture No. 26 in the Portfolio)

1. Coral Spot.
2. Candlesnuff on wood.
3. Jew's Ear on Elder branch.
4. Cup Moss.
5. Stinkhorn.
6. Puffball and vertical section.
7. Stagshorn.
8. Fly Agaric and vertical section.
9. Honey Fungus.
10. Sulphur Tuft.
11. Matt Russule.
12. Verdigris Toadstool.
13. Mild Milky Toadstool.
14. Ink Cap.
15. St. George's Mushroom.
16. Beefsteak Fungus with verticalsection.
17. Dryad's Saddle.
18. Stump Flap.

4. *CUP MOSS.*—There are many distinct kinds, but none like moss, though often hidden amongst mosses. White or light-coloured, rough and warty outside; brown, orange and scarlet inside. About ½ in. to 5 or 6 in. in diameter. They are the spore-bearing bodies of fungi.

5. *STINKHORN.*—A creamy, thick stalk arises from a sheathing collar at the base, and bears a small, dark brown, pitted head, which breaks open when ripe to expose a slimy, evil-smelling mass which attracts flies. These feed on the head and bear away the spores and so disperse them, in contrast to

the foregoing species, whose spores are dispersed by wind. In some fungi slugs, beetles, and small mammals such as field mice, disperse the spores in feeding on the fructification. Fields.

6. *PUFFBALL*.—Found in fields and woods. A short, thick stalk bears a globular sac-like head which encloses spores. When these are ripe, a "chimney" appears at the top, and the slightest knock causes the spores to emerge like puffs of smoke. Still used by farmers in some districts as a "styptic" (i.e., to stop bleeding) for wounds of cattle, and formerly used for human beings in the same way (cf. cobwebs). The outside is covered by small, scaly tubercles. White or dingy brown. The vertical section shows the inside before it is ripe, consisting of a network of threads with the cavities filled by ripening spores.

7. *STAGSHORN*.—Slightly similar to candlesnuff in general appearance, but larger, much more branched, and of a bright golden yellow. Bears spores all over surface. On wood, in damp places. Grows 2–3 in. high.

8. *FLY AGARIC*.—A typical "toadstool" fairly common in pastures, and *very poisonous*. Consists of a stalk with a swollen, bulbous base, bearing a flat expanded head which is bright scarlet, covered with loose white scales like flecks of suède, the remains of the universal veil or envelope which at first enclosed the whole toadstool. Below the head is a reflexed ring. This is formed from the secondary veil, which extended from the stalk to the edge of the cap in the young stage (cf. mushroom). Some toadstools have remains of one of these veils, some of both, some of neither. The under-side of the cap is made up of thin membranous folds, called gills, which are covered by spores. The cap protects the spores, and the folding enables a great many to be produced in a small bulk; there is a very large spore-bearing surface. Summer.

9. *HONEY FUNGUS or HONEY-COLOURED TUFT*.—Common in woods, or wherever there are trees, and highly destructive, as it attacks living trees and spreads through them until it exhausts and kills them. Unlike the mycelium of most fungi, the honey fungus has one which forms thick, hard black cords driven through the wood. The toadstool is variable in colour, from pale honey-colour to tan or dingy brown, with white gills, later brownish, and usually a well-developed ring, but sometimes the ring is almost absent. It grows in tufts and the white spores thrown down frequently make a characteristic pattern of the gills on the lower members of the group, which are overlapped by the taller ones. The cap has a sprinkling of powdery black or brown scales. One of the commonest of tufted toadstools. Cap 2–3 in. across. Usually seen October–November.

10. *SULPHUR TUFT*.—Another very common tufted toadstool growing always on tree stumps. Smaller than the honey fungus, about 2 in. across when full grown. At first pale sulphur-yellow all over, with olive-green gills and pale yellow or greenish stalks. Then a golden spot appears in the centre of the cap, which turns ochreous, and spreads to the edges. Later, the cap turns dull brown and the gills become almost black as the black spores ripen. A very pretty toadstool. All through autumn.

11. *MATT RUSSULE*.—The russules grow in woods, and are firm, compact-looking toadstools with clean-looking white gills and stalks, and pink, red, purple or brown caps. This species is pink. Many of them will be found nibbled, possibly by wood mice, squirrels or rabbits. The gills all run from the stalk to the edge of the cap; i.e., there are no short ones in between, and are fairly thick. The cap is domed at first, then becomes flatter and often slightly hollow round the edge. On ground in woods throughout autumn.

12. *VERDIGRIS TOADSTOOL.* — A pretty, medium-sized toadstool of a pale bluish-green—the colour of verdigris. This is due to a slime or mucus, which gradually dries to a pale tan. Common in thickets among grass and brambles, and small specimens often found on lawns. White spores.

13. *MILD MILKY TOADSTOOL.*—One of a tribe (*Lactarius*) which all ooze milk when broken, sometimes coloured and in one case peppery in taste. This one has a very mild, slightly nutty flavour, and the milk is not always copious. It is white. The toadstool is a light cinnamon colour, fading to tan, and is dry-looking. It has a characteristic trim, clean-cut form with a firm stalk and cap and smooth edge. At first round and flat like a coin, later hollowed out into a conical cup. Slightly striate. Common in woods and thickets in autumn, the cinnamon colour catches the eye.

14. *INK CAP.*—The example figured is one of the commonest of the ink caps, but there are many different kinds, some large, some small, usually associated with well-manured ground. They are black-spored toadstools, all having in common the breaking down of the mature form in a liquefying (deliquescent) mass, leaving eventually nothing but a little pool of ink-like fluid, which finally dries up. The ink cap figured is found in fields, gardens and lawns, on the ground or decaying tree stumps, but not on dung. The cap is thin, greyish with brown centre, silky and fluted, the gills white at first, later grey, then black, the stalk white, shining and brittle. Slight ring, which soon disappears. It grows in large tufts, and is found in the autumn. Edible when young. Stalk 4–6 in. high and cap 2–3 in. high.

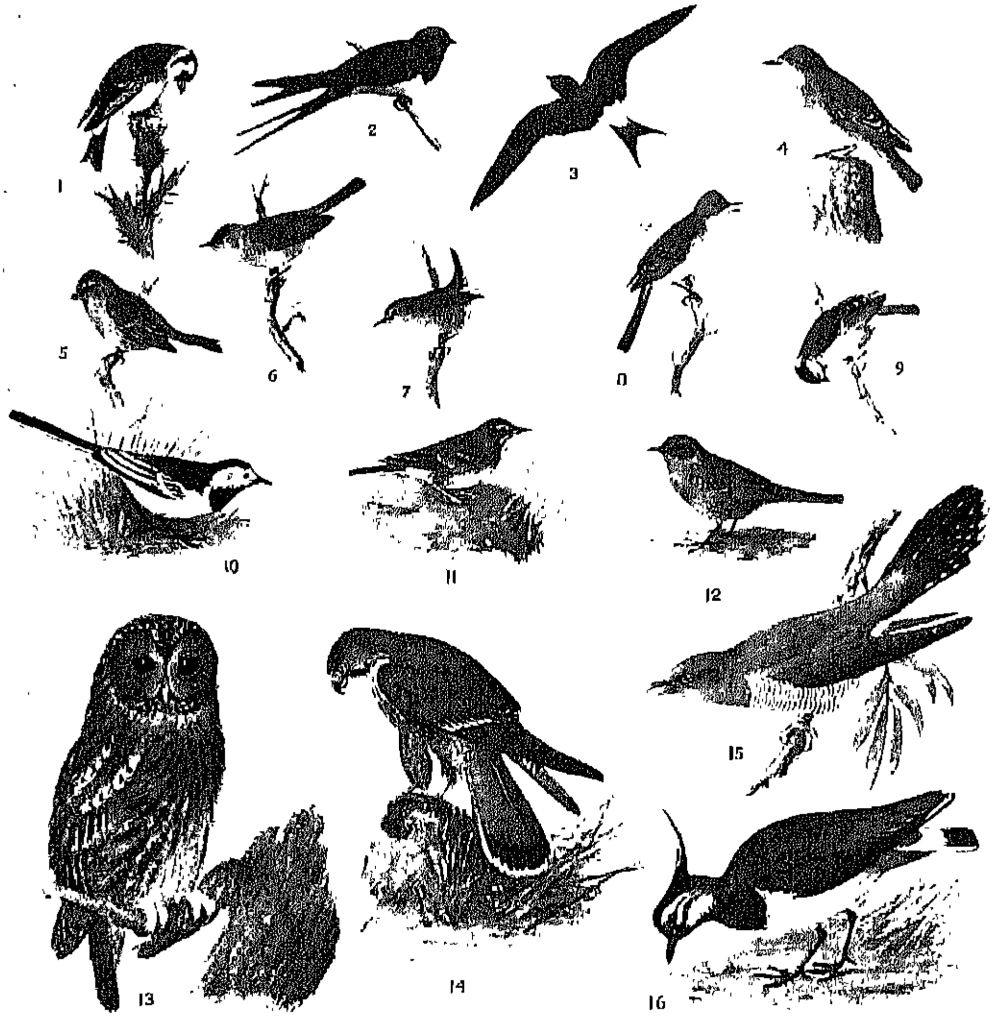
15. *ST. GEORGE'S MUSHROOM.*—Often forms fairy rings in pastures in spring. Light tan-coloured, thick, stumpy forms, with shallow conical cap. Smell like new meal. Stem 2–2½ in., cap when full-grown 3–5 in. across. Gills crowded and whitish. Edible.

16. *BEEFSTEAK FUNGUS.*—A shelf-like fungus growing on trees in woods, resembling thick slabs of liver in texture and colour, and when cut open, having the fibrous appearance and blood-red colour of beefsteak. Often several flaps overlapping. It bears spores in tubes, opening by pores on the under surface, hence belongs to the group of polyporae.

17. *DRYAD'S SADDLE.*—Another polypore. The large, fan-shaped, tough-looking cream-coloured masses, striated with light brown and scaly on the upper surface, are well-known parasites on trees, which do considerable damage to the tissues. The fungus should be destroyed as far as possible when seen, as like the honey fungus, it will scatter spores which will infect other trees in the neighbourhood. Any tree which produces the fructification is already seriously infected.

18. *STUMP FLAP.*—A pretty, diminutive relative of the beefsteak and dryad's saddle, whose thin, dainty flaps overlapping one another, are common on decaying tree stumps and logs, especially near the ground. The lower side is cream and covered with shallow pits, which on close inspection can be seen to consist of minute pores, from which the spores fall. The upper side is richly shaded with bands of green, brown and yellow, parallel with the edge, and fine radial striations. It is also covered with very short, silky hairs which give the surface a velvety appearance. The semicircular, horizontal flaps not more than 2 in. or so in diameter.

BIRDS THAT HELP THE FARMER



Birds that Help the Farmer

(Class Picture No. 31 in the Portfolio)

1. Goldfinch.
2. Swallow.
3. House Martin.
4. Flycatcher (Spotted).
5. Lesser Redpoll.
6. Blackcap.
7. Wren.
8. Whitethroat.
9. Coal Tit.
10. Pied Wagtail.
11. Meadow Pipit.
12. Hedge Sparrow.
13. Tawny Owl.
14. Kestrel.
15. Cuckoo.
16. Peewit.

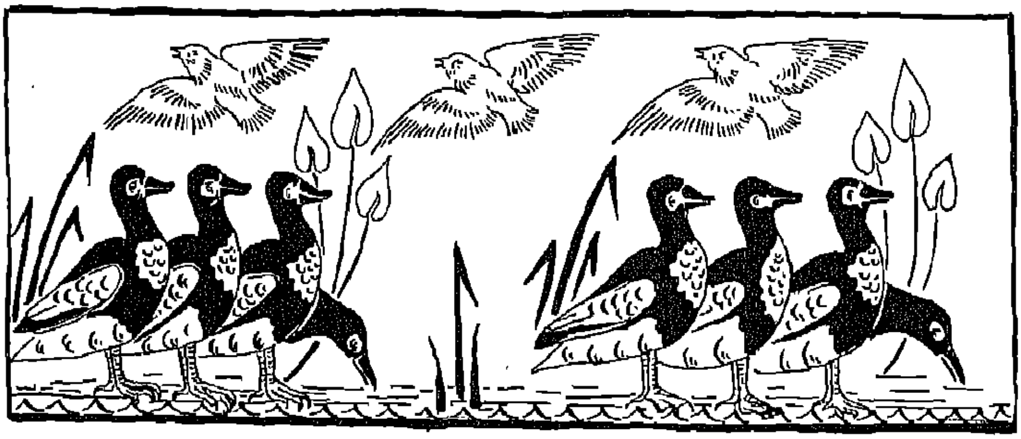
THE usefulness of birds to gardener and agriculturist consists in keeping down the numbers of weeds and injurious insects by feeding upon the seeds, eggs, larvae, pupae and full-grown insects. Consequently any birds that dig in the ground or in tree trunks and wood for these things, visit plants like thistles and cow-parsley for their seeds, or catch flies, butterflies and moths on the wing, may be regarded to that extent as useful. In some cases; e.g. blackbird, their usefulness is counteracted by their depredations in orchards and amongst soft fruit bushes, and it is not easy to collect accurate data to strike a balance. On the whole these birds must be regarded as beneficial.

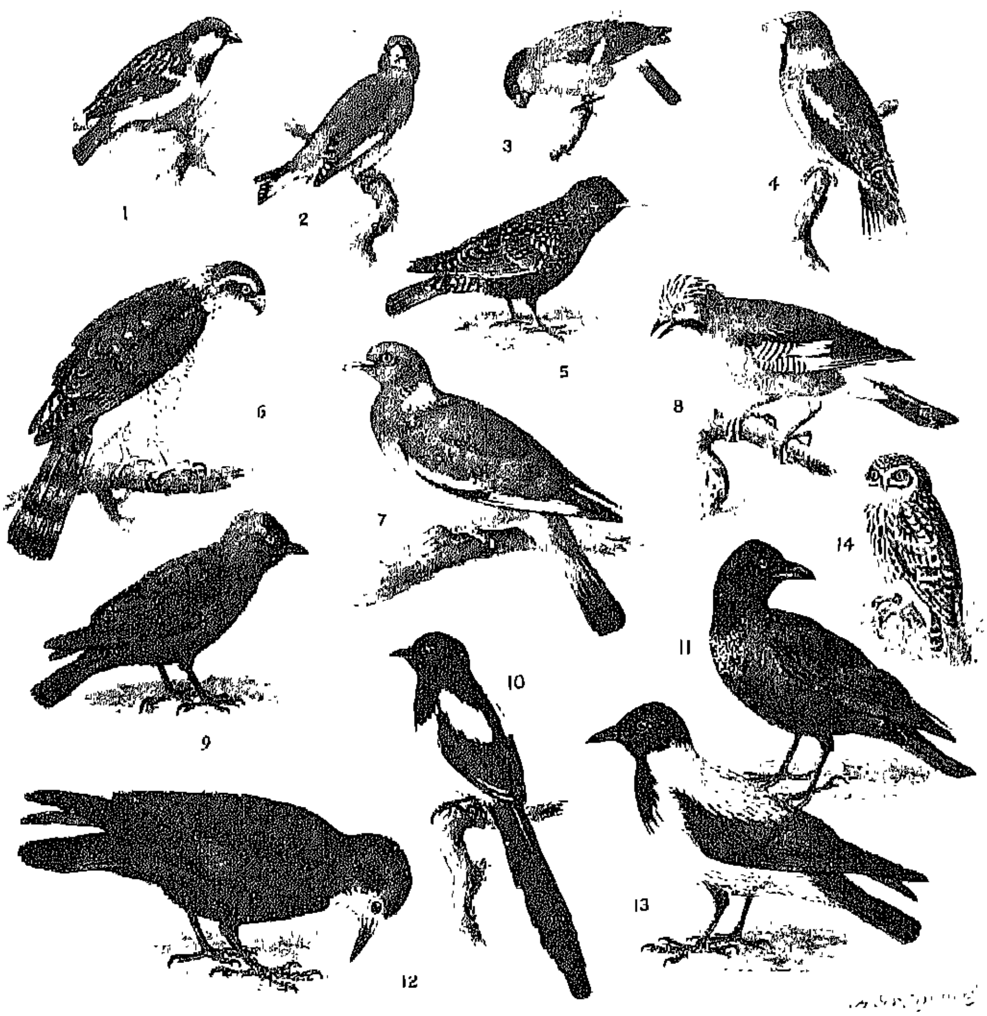
BIRD	OUTSTANDING POINTS FOR RECOGNITION	VALUE TO FARMER	TIME AND PLACE OF NESTING	RESIDENT OR MIGRANT
GOLDFINCH	Broad gold bar on wing. Red, black and white head. Size of sparrow.	Eats seeds of weeds and larvae.	April—May. Creamy eggs, blotched red or purple. Compact nest of roots, grass and moss.	Migrant.
SWALLOW	Forked tail and no white on back distinguish it from martin. Dark bluish plumage with red on head and white spots on tail feathers.	Catches insects on wing.	Under eaves. Mud. Shallow saucer shape.	Migrant.
HOUSE MARTIN	White rump and under-side. Rest dark brown.	Catches insects on wing.	Under eaves. Half-cup shape. Made of mud. Eggs early June. Whitish. Second brood later.	Migrant.
FLYCATCHER (SPOTTED)	Small, slim, greyish-brown bird, faintly striated. Darts out from tree to catch flies on wing, and darts back to same spot. This habit more distinctive than any points in appearance.	Catches flies.	Nests in walls, trellis beams and about buildings, loosely made of grass and moss. Eggs early June, dull white with reddish spots.	Migrant.
LESSER REDPOLL	A small finch, very like linnet but with a black chin, and smaller. Crimson forehead and crown.	Seeds and larvae of insects.	Bush or brambles in May. Small and deep, with small sticks. Eggs deep blue-green with reddish spots.	Resident.

BIRD	OUTSTANDING POINTS FOR RECOGNITION	VALUE TO FARMER	TIME AND PLACE OF NESTING	RESIDENT OR MIGRANT
BLACKCAP	Pale fawn with black cap. Female has brown. About size of linnet and slim. A warbler with very sweet song.	Insects, larvae and pupae.	Thick bushes, late May. Material, grasses and sedges. Yellowish or reddish eggs, mottled and clouded with deeper tint.	Migrant.
WREN	Short brown body and tip-tilted tail. Mouselike movements in hedges. Loud, sweet song.	Insects in all stages.	Base of hedges and tree stumps. Materials, grass, moss, leaves. 3-10 white eggs.	Resident.
WHITETHROAT	A warbler, closely related to blackcap and of similar colouring but V-shaped white patch on throat.	Insects in all stages.	Near ground in low bushes or herbage. Eggs late May, greenish-white speckled grey but variable.	Migrant.
COAL TIT	Black head with white spot on nape distinguishes it from marsh tit, which has no white spot. About size of blue tit.	Searches for small grubs.	Holes in tree stump, disused rabbit burrows; near ground. White eggs, spotted red. May.	Both.
PIED WAGTAIL	Slender, trim bird, between thrush and sparrow in size. Grey, black and white with long jerking tail.	Insects, searching the ground chiefly.	Low down, near water. Materials, moss, grass, roots. 4–6 eggs, bluish-white or brown, with yellow marks.	Migrant, but some all the year round.
MEADOW PIPIT OR TITLARK	Like a small skylark, but without crest. Light brown and speckled.	Insects, searching ground.	Upland fields and moors slightly sheltered by tufts of grass. Dark reddish-brown, closely speckled eggs.	Both.

BIRD	OUTSTANDING POINTS FOR RECOGNITION	VALUE TO FARMER	TIME AND PLACE OF NESTING	RESIDENT OR MIGRANT
HEDGE SPARROW, HEDGE ACCENTOR OR DUNNOCK	About size of robin. Brown back striated darker. Light slate-grey on head and breast. Sweet song. Hedge *accentor* a better name as it is not a sparrow, and its song is constantly repeated and insistent.	Eats insects feeding on the ground in gardens under cabbages and other crops, and in hedge bottoms, especially weevils, seeds.	Hedges, evergreen bushes, faggots or banks. Sky blue eggs in March or April, and a second brood later.	Resident and partial Migrant.
TAWNY OWL	A woodland bird, its call is the long drawn-out mournful hoot commonly heard at night. Warm buff, mottled dark brown, with light bars on wings.	Feeds on mice and small voles, which destroy grain.	Hollow trees and holes in old buildings. White eggs.	Resident.
KESTREL OR WINDHOVER	Poises 20–30 ft. above earth, when silhouette shows wings projecting further than end of tail. Slides along at same height then moves off with slow, steady wing beats, searching a field systematically. Often male and female can both be seen at work. Chestnut with lighter barred breast and slate-blue head and tail. Commonest British hawk.	Feeds almost entirely on mice and beetles though pheasant chicks and small birds such as starlings will be taken if chance occurs.	No true nest. Eggs laid on high ledge, slight hollow, or deserted nest of another bird. Always high up. April–May.	Both.

BIRD	OUTSTANDING POINTS FOR RECOGNITION	VALUE TO FARMER	TIME AND PLACE OF NESTING	RESIDENT OR MIGRANT
CUCKOO	Larger than a blackbird, with long slim body and very long tail. Slate-grey; breast lighter with dark bars.	Eats caterpillars and leatherjackets in large quantities. One of few birds which eat hairy caterpillars.	Places one egg at a time in nest of some other bird, curiously, much smaller than itself, e.g. meadow pipit, or hedge sparrow.	Migrant.
PEEWIT, LAPWING OR GREEN PLOVER	About size of pigeon, with striking crest and rounded, flapping black and white wings. Glossy green back and chestnut above and below tail can be seen at close quarters. Wheeling flight.	Wireworms, caterpillars, leatherjackets, snails and slugs.	On ground in ploughed fields, grass, moorland, any open site. March onwards.	Resident, but many winter arrivals add to the number from other countries.





Birds of Doubtful Character

(Class Picture No. 32 in the Portfolio)

1. House Sparrow.
2. Greenfinch.
3. Bullfinch.
4. Hawfinch.
5. Starling.
6. Sparrow Hawk.
7. Wood Pigeon.
8. Jay.
9. Jackdaw.
10. Magpie.
11. Carrion Crow.
12. Rook.
13. Grey or Hooded Crow.
14. Little Owl.

BIRDS OF DOUBTFUL CHARACTER

The injury done by birds to crops, or by birds of prey, is usually only of importance if those birds occur in great numbers. For instance, starlings, from being extremely useful insect-feeders, seem to have been forced by the extraordinary increase in numbers in recent years to change their feeding habits and have become a menace to fruit growing, especially in apple, pear and cherry orchards, and also take large quantities of grain. The gregarious habit, too, increases the trouble. On the other hand, where pests of insects arise they may be invaluable; e.g., in Bavaria, 1889-91, nun moths were a plague, and flocks containing as many as ten thousand birds were seen feeding on the larvae and pupae (Ministry of Agriculture Leaflet No. 208). The problem therefore is to keep the right balance, and not allow any birds to increase to such an extent that they begin to feed extensively on ready-made (man-provided) foods.

AGAINST	FOR
HOUSE SPARROW	
Large proportion of food is cultivated grain, especially just before harvest. Damage garden produce; e.g., pull up young peas. Strip buds of currant and gooseberry bushes, tear brightly-coloured flowers such as crocuses. Eat young carnation shoots in winter. Damage ricks and thatch. Block drains, pipes and gutters with nests. Drive away useful insect-feeding birds such as martins. They are thus most injurious in corn-growing country but only welcome in limited numbers anywhere.	Eat seeds of weeds. Feed young on aphides, caterpillars, larvae and adult beetles, crane flies, and to some extent adults feed on these.
GREENFINCH	
(Sometimes called "green linnet.") Does considerable damage to crops, especially through digging up seeds in gardens before they have time to germinate. Numbers need to be controlled near cultivated land.	Feeds on insects and larvae and feeds young on these. Feeds on seeds of weeds.
BULLFINCH	
Has a pronounced liking for fruit buds, and destroys far more than it eats, hence is injurious to orchards and gardens in spring. This *outweighs* good done. It would be a great pity, however, if these, the handsomest of the finches, were exterminated. Again, control is desirable but not wholesale slaughter. In fruit-growing areas the bird is definitely undesirable.	Feeds on seeds such as groundsel, chickweed. Probably does not do much harm to cultivated fruits, as its preference is for berries, such as wild rose, hawthorn and rowan.

AGAINST	FOR
HAWFINCH	
Has a great liking for damsons and cherries, especially the stones, which it cracks with its powerful beak. Not common enough to be a menace, but does considerable damage to fruit and is especially fond of peas. Should not be allowed to become too prevalent, but is at present rare in many places and rather local in its distribution, though it is said to be increasing and extending its range.	Feeds young on insects and their larvae.
STARLING	
The flocks are the great menace as they can easily ruin a crop, for instance of sprouting grain. Destroy considerable quantities of fruit. Are on increase and need to be strictly controlled. Grain as well as germinating plants taken. *Definitely injurious.*	Their large flocks will clear whole areas of the kinds of insects which are also likely to appear in large numbers; e.g., cockchafers, leatherjackets, certain moths, which have surface caterpillars ("cutworms"). Help to keep down the external parasites of sheep, such as ticks, by pulling them out of the wool or skin. The food of 40 nestlings examined contained 89% injurious insects. (Ministry of Agriculture Leaflet No. 208.) Would be *valuable* if *numbers* considerably reduced.
SPARROW HAWK	
In killing the small birds which are insect-feeders, the sparrow hawk is likely to promote the increase of insect pests. It raids chicken runs at times. It will also eat frogs, which are useful in keeping down insects, slugs and snails.	In so far as it kills Sparrows it does useful work. It does kill some mice. Careful observers say its victims amongst game chicks are very few. Unlike the kite it does not hover but flies low along the hedges.
WOOD PIGEON	
Unquestionably the most injurious of all British birds, all the year round. A constant succession of crops is attacked, at all stages from germinating seeds to fruits. Only a few can be mentioned here, viz:—wheat, oats, beans, peas at all stages; cabbages and rape, sometimes ruining a crop in winter; buds of trees; potatoes; clover leaves; tops of turnips, while roots are "holed;" fruit such as cherries, currants and gooseberries.	Weeds such as dock and chickweed but not enough to balance depredations.

AGAINST	FOR
JAY Takes a good many eggs and young of other birds, including game, and is fond of garden produce, especially beans, peas and soft fruits.	Feeds on insects, slugs, mice. On balance probably beneficial rather than otherwise, though it would be difficult to convince gardeners and gamekeepers of this, as its good works are less in evidence than its bad. Essentially a woodland bird, only visiting gardens and fields near woods.
JACKDAW As *Jay*. Egg thief, will visit poultry yards.	As *Jay*. On the whole beneficial in destroying many agricultural pests, provided numbers are not too great.
MAGPIE As *Jackdaw*.	As *Jackdaw*. Rather helpful on the whole.
CARRION CROW Omnivorous in feeding, will take hens' eggs and young chicks, as well as young game-birds, hares and rabbits. Actually eats little carrion. Its destruction of eggs and game renders it a nuisance, and its crimes outweigh its good deeds, especially to poultry farmers.	Will take rats and mice and insects. Hunt in pairs, and can be distinguished from adult rooks by the feathers coming right to the beak; in the rook there is a bare patch just above.
ROOK Undoubtedly takes a good deal of grain and to some extent attacks other crops, such as potatoes and roots.	Takes a great deal of insect food from the soil, especially leatherjackets, cockchafers and caterpillars which injure crops. The problem is again one of numbers, and varies in different districts and at different times. The competition of starlings has probably driven rooks to take more agricultural produce and their control might put matters right for the rooks by giving them more supplies of their natural foods. In moderation they are definitely friends of the farmer.
GREY or HOODED CROW A local winter visitor, coming to the east coast of England, and all over Scotland and Ireland from Europe. Its habits are much the same as the carrion crow's. It is a great egg thief and destroyer of game. T. A. Coward mentions that it is feared and hated on the sheep runs, but does not say why.	Although its record is undoubtedly black, it does act as a scavenger on the coast, feeding on fish refuse and other decaying matter. It would be a pity, however, to exterminate an interesting visitor, though it undoubtedly needs to be strictly controlled.

AGAINST	FOR
LITTLE OWL Not a native of Britain, but introduced by several people from 1840 onwards, it at last began to establish itself and nest in the Midlands and southern counties, and has been regarded by gamekeepers and farmers as a pest, though its pellets show that its food is chiefly small mammals and beetles. It is exceptional amongst owls in being diurnal, and may often be seen flying in the afternoons. It is said to raid hens' nests and steal eggs and chickens in open daylight, but it is difficult to obtain reliable evidence. Length only 9 in.	Feeds mainly on insects, including beetles, earwigs and daddy-long-legs, also on small mammals. A report published in February, 1938, by the British Trust for Ornithology, which has made a scientific investigation into the food of the little owl, shows it to be a much maligned bird. Out of 2,460 pellets examined, only one game chick was found.

A YEAR'S WORK IN THE VEGETABLE GARDEN

January.—Complete the winter digging of vacant land to give alternating frost and thaw a chance to mellow it. The minimum depth is 1 ft. Dig 2 ft. deep, however, for special crops such as peas, broad and runner beans. Manure generously for all crops save carrots and parsnips, for which no stable manure must be used.

Celery.—Prepare celery and leek trenches. An ideal width is 18 in. Enrich the ground liberally to the depth of 2 ft. with stable manure and soot; fill up to within 3 in. of the top, arranging the surplus soil in a neat bank along the trench sides.

Spring cabbages.—During wintry spells cover spring cabbages with dried branches or straw. Remove these coverings as soon as normal conditions return.

Mint.—Plant mint in the herb corner. Set the roots 1 in. deep and 4 in. apart, laying them horizontally. Mix plenty of wood ashes and a little manure with the soil.

Seed potatoes.—Set up seed potatoes to sprout in shallow boxes in a cool, light environment. Place the tubers with the rose or round ends upwards. It is from these ends that the strongest sprouts shoot.

Rhubarb.—Lift rhubarb, for forcing in a dark, warm environment. Turn the roots upside down, and expose them to the elements for a fortnight before planting. When planting, cover all but the crowns or tops with ordinary garden soil. Keep the bed moderately moist, or growth will dry up.

Cropping scheme.—Prepare the season's cropping scheme. The rules of rotation cropping demand that no kind of crop shall occupy the same land as it did last year. Having completed the scheme, order the necessary seed. It is an advantage to have this on hand before the rush of spring work begins.

Paths.—Dress weedy paths with agricultural salt at 2 oz. per sq. yd. This preparation quickly exterminates all aliens and is equally successful in wet weather and dry.

February.—Broadcast radishes, lettuce, six-week turnips and some shorthorn carrots thinly on a 4 in. deep bed of good garden soil formed on a 2 ft. deep hotbed. Just cover the seed with fine soil and keep the frame lights closed until the seedlings appear. Afterwards, ventilate and water carefully and there will be splendid early, out-of-season crops.

Hotbed.—The hotbed may also be used for sowing onions, leeks, celery, Brussels sprouts, summer cabbages, and cauliflowers. Use boxes of sandy soil and, until the seedlings appear, cover them first with glass, then brown paper. Not only does this method ensure earlier, heavier yields, but also comparative immunity from several serious enemies.

Shallots.—Plant shallots in firm, well-manured ground at an all-round distance of 9 in. apart. Place ¼ in. layer of sand beneath each bulb to ensure healthy rooting. The brown variety is superior to the red.

Broad beans.—Sow Longpod broad beans in rich soil. Make 9 in. wide, 3 in. deep flat-bottomed drills, running north and south if possible to secure maximum benefit from sunshine. In each drill set two rows of seed at an all-round distance of 6 in. apart.

Preparing ground.—Fork previously dug ground 1 ft. deep, breaking up the lumps finely. This is a splendid preliminary to the preparation of a good seed bed.

Winter greens.—Pull up spent winter greens which rob and contaminate the ground if left in. Burn the stumps and prepare the site for the next occupant.

Seakale and rhubarb.—Cover seakale and outdoor rhubarb with inverted boxes to promote early growth. Surround each box with a 1 ft. layer of fermenting manure as a further aid to early development.

Stored crops.—Examine stored crops; remove the white sprouts from potatoes and secondary leaves from carrots and beetroot. Eliminate decaying roots also, and from now onwards admit more air to the storage environment.

Sage.—Divide and replant sage if the plants have been in their present position for more than three years. In the new bed, space the plants 15 in. apart, adding a good dressing of well-rotted manure when digging 1 ft. deep.

Onions.—Give autumn-sown onions a dressing of weathered soot, and hand weed the drills. The surplus seedlings may now be withdrawn and used as salad.

March.—"A peck of March dust is worth a king's ransom." This wise old saw means that there are many excellent planting and sowing opportunities which should be seized whenever the ground works nicely. Catch up with arrears of digging and forking, therefore, so that the golden chance does not slip by.

Sowing peas.—At the first opportunity sow a good early pea such as Laxton, setting the seed 3 in. apart in 9 in. wide, 2 in. deep flat-bottomed drills. Steep the seed in paraffin for three minutes, and roll it in red lead as a safeguard against attack by mice. Provide rich soil.

Sowing peas in the cold frame.—A specially early pea crop is ensured by sowing seed of the same variety in the cold frame. Space it 2 in. apart, and set it 1 in. deep in 2½ in. deep boxes. These seedlings are planted out in April.

Red cabbages.—Plant red cabbages 18 in. apart in firm, fairly rich soil. If the plants are set in 3 in. deep drills, cold ground winds will miss the main stem and early growth will be much more successful.

Spring cabbages.—Give each spring cabbage ½ teaspoonful of nitrate of soda, stirring it in as near the main stem as possible, without touching the growth. This fertiliser acts so quickly that cabbages will be ready for cutting three weeks earlier.

Good King Henry or *Mercury.*—This plant belongs to the species *Chenopodium*—Goosefoot. It is a lovely perennial spinach-like vegetable that may be planted in March. Set the roots 1 ft. apart in good soil, and from the end of May to the end of the season, the bed will never be out of production.

Preparing soil.—Lime the soil in which it is intended to grow summer greens and Brussels sprouts. The rate of application is 8 oz. per sq. yd. and the lime must not be forked in more than 4 in. deep, or some of it will be lost.

Jerusalem artichokes.—Early in the month plant Jerusalem artichokes 5 in. deep in drills spaced 3 ft. apart. Set the tubers 1 ft. apart in the drills. The windward side of the garden is a good position for this crop, which on account of its tall growth affords welcome shelter.

April.—Give shallots a 1 oz. per sq. yd. dressing of sulphate of ammonia, hoeing it in. This fertiliser promotes quick growth, which is just what shallots need in view of their short season.

Peas.—Sow second early peas about the middle of the month, this time setting the seed 3 in. deep in 9 in. wide drills. If the soil is very dry, take out the drill the day before, and fill it with water.

The Dutch hoe.—Weeds are now beginning to appear in force, and the soil is starting to cake. The regular use of the Dutch hoe will destroy the former and correct the latter serious condition.

Cabbage lettuces.—Early in the month sow one of the quick maturing cabbage lettuces such as Commodore Nutt. Broadcast a pinch of seed in a sunny corner, and when the seedlings are large enough to handle, transplant them 6 in. apart in rich soil.

Protection for peas.—Protect early sown peas from birds, using wire guards, small meshed wire netting, or black cotton tightly stretched between slightly projecting pegs placed at intervals of 2 ft. amongst the plants.

Transplanting.—Transplant onions which have been sown under glass; put summer cabbages and cauliflowers in their final quarters after hardening them off thoroughly. All like rich soil, the two last named being planted 18 in. apart, the onions 1 ft. Plant cauliflowers deeply, or they will turn blind; onions shallowly, or they will develop thick neck.

Parsnip seedlings.—Sprinkle sand amongst parsnip seedlings as a safeguard against collar rot. If there is congestion in the seed drills, relieve it by judicious thinning, but go no further with this operation than is necessary.

Parsley.—A little parsley along the edge of the plot makes a pretty picture. Seed may be sown any time this month in 1 in. deep drills. Steep it overnight in clear water to hasten germination, then there is no fear that it will make its proverbial "seven visits to the devil" before coming up.

Mustard and cress.—Mustard and cress may be sown out of doors any time after the middle of the month, and if sowings are repeated at ten-day intervals, the succession can be maintained as long as desired. Distribute the seed thickly on fine, firm soil in a shady spot, and just cover it.

Potatoes.—Early in the month plant first early, second early and maincrop potatoes in well-worked rich land. Make the drills 5 in. deep and plant at the following distances apart:—*first earlies*, rows 24 in., sets in rows 12 in.; *second earlies*, rows 28 in., sets in rows 14 in.; *maincrops*, rows 30 in., sets in rows 15 in. A few of all the sections should be grown, to provide a succession. Where manure was not applied previously, make the drills 8 in. deep spreading a 3 in. layer of manure in the bottom.

May.—May is often a very hot month and seeing that crops have not much cover, it is advisable to hoe frequently. The newly planted crops need watering. If so, do it in the evening.

Cabbages.—Place tarred felt discs round the main stems of all members of the cabbage family, as a safeguard against attack by root fly. If the discs are pressed to the soil level and kept there, this destructive pest will cause no loss.

Peas.—Stake peas when curly tendrils form at the leaf ends. This is a constant job for the next few weeks. Where tree branches are not available, use wire netting or string, both adequately supported by firm stakes.

Brussels sprouts, celery and leeks.—About the middle of this month plant Brussels sprouts, celery and leeks in their permanent quarters. Sprouts need specially firm soil, in which they should be planted at an all-round distance of 30 in. apart. Celery and leeks are planted 9 in. apart. In double row trenches the plants should be set in pairs, or there will be difficulties at earthing up time. All need regular watering for a time, while if the sun is very hot, celery benefits by slight shading with muslin or tiffany.

French beans.—On the ridge between the celery and leek trenches, sow French beans immediately after planting the latter. The Prince is a fine variety. Set two rows of seed at 6 in. apart in a 9 in. wide, 2 in. deep, flat-bottomed drill.

Runner beans.—Towards the end of the month sow runner beans in liberally manured land. Set the seed 2 in. deep and 9 in. apart in a single row. Heavier crops result than when the plants are grown in a double row.

Mint.—If yellow blotches appear on mint leaves, spray the plants at once with a rose-pink solution of permanganate of potash. The trouble is Rust Disease, which will cripple the mint hopelessly unless controlled.

June.—Early in the month vegetable marrows may be sown in a mound of soil on the manure heap, or in rich soil in the open garden. Set the seed 1 in. deep and 1 yd. apart. When the seedlings appear, protect them at night for a week or two by placing an inverted jam jar over each.

Tomatoes.—Plant tomatoes early in the month. They will give a yield of 5 lb. per plant if set 18 in. apart in good soil alongside a sunny wall. To help fruit to set, dust the flowers daily with a rabbit's tail or camel's hair brush. Choose a good outdoor variety like Essex Wonder.

Peas.—It is possible to sow peas until the end of the month, but a first early variety must be chosen. The maincrops have no chance to fill their pods. Set the seed 3 in. apart in 9 in. wide, 3 in. deep, flat-bottomed drills.

When early and second early peas finish flowering, remove the growing point of each plant to concentrate nutriment in the developing pods. Assist the latter to fill well by feeding weekly with super-phosphate of lime at the rate of 1 oz. per yd. run of drill. Water the fertiliser in if the soil is dry.

Carrots and parsnips.—By this time maincrop carrots and parsnips are ready for thinning to the final distance of 1 ft. apart. Choose showery weather if possible. If not, water the day before. The superfluous seedlings withdraw more easily from moist earth.

Celery.—Dust celery with weathered soot to ward off the egg-laying flies which are the parents of the leaf mining maggot.

Brassicas.—Towards the end of the month plant savoys, autumn cauliflowers, autumn broccoli, autumn cabbages and curly kale into their final quarters. All like rich, firm soil. Plant curly kale 2 ft. apart, the remainder 18 in.

Onions.—Spray onions with paraffin emulsion to prevent an attack of the onion grub. Begin in early June, and repeat fortnightly until mid-August. This is the formula:—paraffin ¼ pt., soft soap ½ lb., water 2 gall. Dissolve the soap in boiling water before adding the paraffin.

July.—Sow globe beet for use in winter. Soak the seed overnight in clear water to hasten germination. Space the seed in twos at 3 in. apart in 1 in. deep drill set 6 in. asunder.

Runner beans.—Spray runner beans on warm evenings with clear water to prevent an attack of red spider, invigorate growth, and prevent the flowers from falling.

Broad beans.—Remove and burn the tops of broad beans when they finish flowering. If black fly attacks the crops, destroy it by spraying with derris wash, obtainable at the nearest garden shop.

Tomatoes.—Remove the side shoots from outdoor tomatoes, and tie them regularly. Water freely, and after the first fruit starts to colour, feed weekly with sulphate of potash (½ teaspoonful per plant per dose) and dilute soot water (6 pt. per plant per dose) alternately until the end of the season.

Potatoes.—Earth up potatoes when the haulm is 10 in. high, drawing to each side of it a 5 in. high bank of finely pulverised soil. Spray the crop also with Bordeaux Mixture, as a safeguard against Late Blight Disease, which causes the tubers to decay. Bordeaux Mixture can be bought cheaply in paste form at the garden shop.

Carrots.—Run round carrot rows a 1 in. high barrier of sand soaked with paraffin as a safeguard against the attack of carrot grub. The barrier must be 2 or 3 in. away from the crop.

Onions.—Feed onions from early June until the bulbs mature. Liquid manure at quarter strength alternated with sulphate of potash (½ teaspoonful per plant per dose) gives splendid results.

Vegetable marrows.—Remove the growing points of straggling vegetable marrow shoots, otherwise there will be an abundance of sterile growth. As the fruits start swelling, protect them from soil contamination by lifting each on to an inverted flowerpot or saucer.

Brassicas.—Pull up early peas and broad beans as they finish, and crop the ground with late savoys, curly kale, or purple sprouting broccoli.

August.—To provide cabbages for spring, sow in early August in a sunny well-drained plot. Mix a little lime with the soil, broadcast the seed thinly, and just cover it by light raking. Offenham is a very reliable sort.

Carrots.—Sow shorthorn carrots for pulling in late autumn. Make the drills 1 in. deep and space them 6 in. apart. Later, thin the seedlings to 3 in.

Celery and leeks.—Earth up early celery and leeks with 4 in. of finely pulverised soil, similar layers to be added at fortnightly intervals until the stems are covered. Gather celery stems together and tie them loosely before earthing, to keep soil out of the hearts.

Onions.—When autumn onions ripen, bend over the tops to arrest the flow of sap. Lift the bulbs a fortnight later, and after ripening them in full sun for a fortnight, store in a cool, dry, airy shed.

Potatoes.—When lifting potatoes, save "seed" for planting next year, unless the present stock has been grown for more than three years, when it is of no further use. Ideal size for sets is that of a hen's egg. Store the sets in boxes, and green them in full light.

Winter greens.—Earth up winter greens as far as the bottom leaves with finely broken soil, to conserve moisture, encourage surface rooting and afford support.

Runner beans.—If black fly attacks runner beans, destroy it by spraying with soft soap solution (4 oz. in 1 gall. of water). Spray with clear water next day to remove the soap sediment.

Onions.—Sow autumn onions in fairly rich, firm soil, in ½ in. deep drills spaced 1 ft. apart. On no account sow more deeply, or the bulbs will be bottle necked.

Cutting and storing herbs.—Cut sage and thyme on some sunny morning, and spread out in a cool, airy room to dry. When throughly dry, tie the stems in bunches of convenient size and store in the herb cupboard.

Cauliflowers.—To prevent late summer cauliflowers from browning, bend the inner circle of leaves over the curds as soon as they form.

French beans.—Spray French beans vigorously with aired water if the leaves are bleached by red spider. This treatment is a certain cure if carried out on alternate evenings for a week.

September.—When runner beans reach the tops of the stakes, remove the growing point of each plant to concentrate nutriment in the pods below. Feed weekly with dilute liquid manure until the end of the season.

Winter lettuce.—Sow winter lettuce, Hardy Hammersmith, early in the month in well-worked soil. Water regularly and the seedlings will soon be ready to transplant at 6 in. apart into their permanent quarters.

An alternative for stable manure.—The prevailing scarcity of stable manure makes it necessary to look round for alternatives. One of the best of these is to sow white mustard on ground that is now becoming vacant. Dig in the growth when it is 6 to 9 in. tall. The seed should be broadcast thinly and just covered by light raking.

Leeks.—Leeks may still be planted for late spring use, but not in trenches. Set them 6 in. apart on the level garden, spacing the rows 1 ft. apart to allow for the necessary attention.

Tomatoes.—Remove those leaves or parts of leaves which interfere with the ripening of outdoor tomatoes. Remove the growing point of each plant, as no fruit which set after early September has a chance to ripen.

Mint.—Cut down a portion of the mint bed in early September and young growth will quickly appear, maintaining a supply of green mint until well into November.

Rhubarb.—Cut off the flower stems of rhubarb and burn them. On no account must these stems be left lying on the bed surface, or they may introduce Bacterial Disease, which quickly destroys the crowns.

Peas.—If white leaf spots appear on peas, destroy the mildew fungus causing them by dusting thickly with a mixture of 2 parts flowers of sulphur and 1 part freshly slaked lime.

Mushrooms.—A supply of winter mushrooms may be secured by making up a bed now in a dark clean outhouse. The necessary temperature of 55° F. can be maintained by burning a fume-proof oil stove. The bed should be 9 in. deep and should be made of new horse manure turned over on alternate days for a fortnight. Use sterilised spawn, planting pieces the size of a pigeon's egg 1 in. deep and 9 in. apart.

October.—October is the great vegetable harvesting month. Deal with potatoes as soon as the haulm yellows naturally. Lift on a dry day, and after exposing the tubers to the air for twenty-four hours, store them in an environment affording darkness, dryness and freedom from frost.

Carrots.—Carrots are ready for lifting when their leaves fall over. Ease up each root with a fork, afterwards cutting off the leaves as near the root as possible. Store them in an outhouse, covering the roots with 4 in. of moist sand or leaf mould.

Onions.—Lift spring-grown onions when their skins ripen. Spread them out on the garden or in a shed until the tops and roots wither. Then twist off both, and store the bulbs in boxes or bags in a dry, frost-proof place.

Beetroot.—Beetroot, the hardiest root vegetable that is lifted, should be left until the last. Ease up the roots as advised for carrots. Handle them most carefully, or they will bleed, becoming quite valueless for the table. Twist off the leaves, and store as suggested for carrots.

Parsnips.—Parsnips should not be lifted, as their flavour is improved by frost. It is advisable always to keep a portion of the bed covered with straw, so that in the event of hard weather, lifting for the table can proceed.

Winter greens.—From now onwards remove yellowing leaves from winter greens at weekly intervals. If allowed to hang on, they cause rapid deterioration amongst these vegetables.

Frosts.—In early October, frosts begin to be severe. Runner and French beans and vegetable marrows are the first to suffer. They can often be kept alive a few days longer by douching with ice-cold water before the sun rises on the rimed growth.

Clearing the garden.—Many crops are now finishing, and unless they are cleared promptly, the garden soon presents a dishevelled appearance. Burn anything that is diseased, pest ridden or stringy. Chop up the healthy succulent material, and mix it with the manure heap (4 in. of rubbish and 4 in. of manure in alternate layers), thus producing a fine compost for enriching the land.

November.—Plant spring cabbages in their final quarters. They do splendidly after potatoes with no further soil preparation than that of digging 1 ft. deep. Set the plants in 3 in. deep drills at an all-round distance of 9 in. apart, thinning them to 18 in. in spring if all survive.

Brussels sprouts.—Support tall Brussels sprouts with neat stakes, otherwise the plants may be damaged by high wind. Use a knife when gathering the sprouts to prevent stem peeling and decay.

Stored crops.—Examine stored crops and remove any that show signs of deterioration. There is always a little loss immediately after storing, due to the occasional bruising that is inevitable when lifting and handling the crops.

Manuring.—Dig in white mustard sown as green manure. If before doing so the mustard is rolled, or flattened with a rake, there will be less difficulty in covering it.

Asparagus.—Cut down asparagus to within 3 in. of the ground level. Loosen the soil with the fork, and mulch with a 3 in. layer of well-rotted stable manure.

Rhubarb.—Rhubarb may now be planted in deeply worked rich soil at an all-round distance of 3 ft. apart. Bury the crowns or root tops 1 in. deep. For early gathering the variety Prince Albert is the best, and there is nothing to equal Linnaeus for late gathering.

Broad beans.—Sow Seville Giant Longpod broad beans in moderately rich soil. Make the drills 9 in. wide and 3 in. deep. In each drill sow two rows of seed alternately at 6 in. apart. The great advantage of this November sowing is that the crop invariably escapes attack by black fly.

Liming.—November is an excellent liming month. Freshly slaked Derbyshire lime is the best for garden purposes. Fork it in 4 in. deep at the rate of 8 oz. per sq. yd. Average soils need liming once in three years. All things considered, the best way is to divide the garden into three equal sections, and treat one each year.

Weeds.—If there are serious perennial weeds in the garden, such as twitch, cornbind, coltsfoot, this is a good time to eliminate them. Fork deeply, break up the soil finely, and pick out and burn every trace of root or underground stem.

December.—December is an important month for winter digging. Exposure of the soil to alternating frost and thaw as early as this, brings it into the kindliest possible condition by sowing and planting time. That is the secret of successful vegetable growing.

Digging.—In proceeding with this work, remember that neither frost nor snow must be dug in, otherwise they will depress the temperature of the soil for months. The minimum digging depth is 1 ft., but as much land as possible should be dug 2 ft. deep, to increase the food supply, extend the rooting range, and render the crops less liable to injury by summer drought. When digging 2 ft. deep, take care not to bring the subsoil or bottom 1 ft. layer to the surface. It takes at least six years for exposed sub-soil to become suitable for growing. When digging 1 or 2 ft. deep, mix generous supplies of stable manure with the soil. Leave the top layer rough, to expose the maximum surface to the elements.

Out-of-season crops.—Out-of-season crops are greatly appreciated. Early January is the time to sow them on hotbeds—shorthorn carrots, turnips, beetroot, lettuce, radishes, salad onions, corn salad, and the rest. Mid-December is the time to begin preparing the hotbed, and here is the method. Secure a supply of littery horse manure and mix it with an equal quantity of newly fallen leaves. Turn over the heap on alternative days for a fortnight, on each occasion working the outside of the heap to the centre, where the hotter conditions kill the manure flies and grubs. At the end of this period, the temperature will, after ascending, have fallen to 75° F. Make up the hotbed at once—a 2 ft. deep, firmly pressed heap made in a sunny, sheltered corner. Place a cold frame on top of it, a 4 in. layer of good soil on the manure, and all is ready for sowing.

Celery.—Protect celery from frost damage by laying pea sticks lightly over the trenches. Straw answers well where pea sticks are not available, but it must be lifted off for a day at three-weekly intervals to air the celery.

Parsley.—Stir into the soil around winter parsley a light dressing of freshly slaked lime, which not only firms the foliage, but stimulates young fronds to form.

A YEAR'S WORK IN THE FLOWER GARDEN

January.—Repair bald patches in the lawn. Remove the soil 2 to 3 in. deep, fork and firm the underlying soil, and fit in accurately cut patches of turf. Fill in the cracks between the new and the old turf with finely riddled soil to provide a bridge across which grass roots can knit.

Liming.—As soon as tulips and daffodils appear, apply superphosphate of lime at 1 oz. per sq. yd. to encourage the formation of vigorous roots.

Lilacs.—Remove suckers from lilacs, cutting them off where they rise on the roots. These robber growths develop from the stock on which the variety is budded or grafted. They quickly overwhelm it and what should be an object of beauty becomes coarse and unlovely.

Stored dahlias.—Examine stored dahlias, removing tubers and cutting out any rotted pieces. Fill the cavity with dust charcoal or brick dust to prevent the trouble from spreading.

Lilies of the valley.—Plant lilies of the valley in a shady spot. Enrich the soil liberally with equal parts of well-rotted manure and leaf mould. Plant the lilies 4 in. apart and 1 in. deep.

Roses.—Refirm roses and shrubs planted in autumn, otherwise they may perish through lack of effective soil contact.

Protection for the budding point of roses.—Wrap the budding point of weeping and upright standard roses with sacking or canvas, which must be tied securely. This budding point, which lies just beneath the head of branches, is very susceptible to frost damage.

Polyanthuses.—Remove yellow leaves from polyanthuses, and stir into the soil a liberal dressing of weathered soot. Examine the plants carefully for slugs which often damage them severely. Drop any that are found into a pail of brine.

Soil preparation.—Prepare sweet pea soil, enriching it moderately to a depth of 2ft. with stable manure and bone meal. This flower is more beautiful when grown in 2 to 3 ft. wide clumps than in continuous rows.

Lilies.—Plant bulbs of the beautiful cream spire lily (*Galtonia candicans*). Set them 9 in. apart and 5 in. deep in sunny borders. ¼ in. layer of sand beneath each bulb preserves the root plate, and ensures healthy rooting.

February.—Sow snapdragons, zinnias, petunias, salvias, and verbenas for summer bedding in boxes on the hotbed. Prepare the hotbed as advised in the vegetable section on page 175. Cover the manure with 1 in. layer of small cinders, and stand the boxes on these. Drain the boxes with 1 in. layer of rough leaves, fill them to within ½ in. of the rim with sandy soil, sow thinly, water through a fine rosed can and cover the boxes with glass and brown paper until the seedlings appear.

Clematis.—Prune tall-growing clematises, cutting back the shoots to within 15 in. of the ground level. Afterwards fork in 18 in. of a light dressing of well-rotted manure on all available sides of the stems. Clematises may also be planted now. They like a west or a south-west aspect. Comtesse de Bonchard (pink), Jackmannii (purple), and

Jackmannii alba (white) are three delightful kinds.

Winter jasmine.—Prune winter jasmine as soon as the flowers fade, shortening the flowered shoots half-way back.

Lawns.—About the middle of the month dress the lawn with a mixture of 4 parts superphosphate of lime and 1 part each of sulphate of ammonia and sulphate of potash at the rate of 1 oz. per sq. yd. Water the dressing in, to prevent temporary turf burning.

Planting.—Rose, shrub and herbaceous planting may now be resumed. Manure moderately for roses, generously for shrubs and herbaceous plants. In every case make the planting hole wide enough to receive the outstretched roots comfortably. Bury the budding point or swelling towards the stem base of roses 1 in. deep. Plant shrubs on the level of the soil mark—a dark ring on the main stem. Cover the crowns or tops of herbaceous plants 1 in.

Soil preparation.—Prepare the dahlia border, digging it deeply and manuring generously. In addition to manure, wood ashes and soot must be freely mixed with the top 1 ft. layer.

Privet hedges.—Cut back overgrown privet hedges. The branches can be shortened to any height desired. Privet breaks new growth freely from hard wood.

March.—For the herbaceous border dig 6 in. deep, burying the residue of last autumn's mulch. Break up the soil finely, and sprinkle on the surface a 2 oz. per sq. yd. dressing of freshly slaked lime. If slugs attack the young growth, surround each plant with ½ in. thick 3 in. wide ring of cinders as a safeguard.

Sweet peas.—Sow sweet peas early in the month, at a depth of 2 in. Set two rows of seed around the edge of clump sites at an all-round distance of 6 in. apart. Where the plants are to be grown in continuous lines, set two rows of seed in each drill.

Pruning roses.—From the middle to the end of the month, according to the district, prune roses. This is a most important operation. Each shoot of vigorous growing dwarf varieties should be cut half-way back, each shoot of the less vigorous to within two buds or eyes from the base. Shorten the side shoots of climbing varieties to within three eyes from their bases. Cut out of ramblers last year's flowered wood. Wear gloves; use a sharp knife; make upward slanting cuts immediately above the selected buds, and as a hygienic measure, burn the prunings.

Conifers.—Conifers may be planted this month. Lovely kinds are Cupressus Stewartii (golden variegated leaves) and Cupressus Allumii (silver variegated leaves). Mix plenty of leaf mould with the soil, and if dry weather prevails, spray daily with clear water until young growth is formed.

Lilies.—Plant the Liliums croceum (orange), regale (white and pink), tigrinum splendens (orange, with black spots), and chalcedonicum (scarlet). Set the bulbs 4 in. deep and 6 in. apart in colonies of three to six. All love sunshine and good soil.

Lawns.—Roll the lawn twice each week when the surface is dry. Pass twice over each spot, and at each rolling start from a different position; e.g., east to west, and north to south.

April.—Plant violas and pansies 8 in. apart along path edges, in rose beds and in clumps in the herbaceous border. Water copiously until growth restarts, and for a fortnight remove the flower buds.

Gladioli.—Plant large flowered and Primulinus hybrid gladioli in deeply dug, rich soil. Set the bulbs 9 in. apart and 3 in. deep. Before filling in each hole, sprinkle the bulbs with flowers of sulphur as a safeguard against Smut Disease.

Lawns.—Start lawn mowning. Oil the machine on the path, never on the lawn. Lift the cylinder into the top notch, dropping it to the bottom at the second mowing. A close cut on the first occasion is injurious to the young grass.

Hardy annuals.—Sow hardy annuals—calendulas, clarkias, annual chrysanthemums, cornflowers, nigellas, Californian poppies, and so on in separate beds, borders and in vacant spaces in the herbaceous border. Broadcast the seed thinly, and cover it by light raking or sow in 1 in. deep drills, according to the type of display desired.

Pruning.—Reduce the shoots of the following herbaceous subjects to six of the best per plant:—Michaelmas daisies, phloxes, heleniums, sunflowers, rudbeckias, and centranthuses. Cut off redundant shoots where they arise on the roots.

Climbers.—Tie or nail all kinds of climbers to their supports. The branches are now hanging heavy with foliage and unless adequately supported, may be broken by the weight of heavy rain.

The Dutch hoe.—Use the Dutch hoe wherever there are weeds or soil caking. If the first batch of weeds is destroyed, the garden will be pretty clear throughout the season. If soil caking is prevented, much moisture will be conserved.

Hyacinths and tulips.—Stake Dutch hyacinths and tulips and, to prolong the display, mulch between the plants with 1 in. layer of short manure or lawn mowings.

Wireworms.—If wireworms are attacking border carnations, destroy them by hoeing into the bed a 2 oz. per sq. yd. dressing of an equal part mixture of naphthalene and freshly slaked lime.

May.—Remove weak inside shoots from dwarf roses. If green flies are feeding in the growing points, destroy them by dusting with tobacco powder.

Border chrysanthemums.—Plant border chrysanthemums at an all-round distance of 18 in. apart, in a sunny rich border. Stake each specimen immediately after planting, water regularly until growth restarts, and for two months dust fortnightly with weathered soot, to keep leaf mining maggots at bay.

Lawns.—Kill daisies on the lawns by dressing them thickly with lawn sand in dry weather. If rain falls within four days, the lawn sand loses its potency, and the dressing must be repeated.

Biennials.—To provide beautiful flowers for next spring, sow wallflowers, forget-me-nots, double daisies and polyanthuses, the three first named in a sunny situation, the last named in partial shade. Make the drills ½ in. deep and space them 1 ft. apart.

Tulips.—When Darwin tulips cease flowering, nip off the faded blooms, and if the ground is needed for summer flowers, replant the tulips in a reserve corner, leaving them there until growth dies down naturally. Then lift the bulbs, ripen them in full sun, and store in a cool, dry shed.

Summer bedding flowers.—Plant summer bedding flowers—snapdragons, stocks, asters, calceolarias, and the rest. In each case make bold masses of colour rather than straight lines. They are much more effective. Before planting, dig the beds 1 ft. deep, and if there is any difficulty in breaking down the lumps, soak them with water, and they will fall to a fine powder when drying out.

Pruning.—Remove the straggling side shoots of Cupressus macrocarpa and Cupressus lawsoniana. Use scissors, and take off each shoot separately. All Cupressus are badly mauled by shears.

Sweet peas.—Water sweet peas with lime water (1 oz. of freshly slaked lime in 2 gall. of water, and 1 gall. per yd. of row or clump). This treatment firms the foliage, and prevents the buds from dropping prematurely.

June.—Plant dahlias early in the month in a rich, sunny situation. Space the large flowered decorative, cactus, and show varieties 3 ft. apart; singles, charms, and pompoms 2 ft.; mignon or dwarf bedding sorts 18 in. Water consistently until growth restarts.

Lilacs.—Prune lilacs, shortening the flowered shoots half-way back. Cut out entirely the weak, sappy inside shoots, and if suckers arise from the roots of named varieties, remove them at their source.

Herbaceous plants.—Stake herbaceous plants as they need it. In all cases tie loosely enough to preserve the natural deportment of the plant. Where twiggy hazel branches are available, these are an ideal method of support.

Roses.—Roses must now be fed at fortnightly intervals until the end of the season. An excellent mixture is superphosphate of lime 5 parts, sulphate of ammonia and sulphate of potash 1 part each. Give one teaspoonful to each bush per dose. Sprinkle the mixture evenly on the soil near the main stem, stir it in if the soil is moist, water should it be dry. If rose leaflets are curled, remove and burn them. The maggot of the leaf-rolling sawfly is feeding inside each leaflet. There is no other remedy except hand picking.

Paeonies.—Cut off the faded flowers of paeonies, and mulch the roots with leaf mould or stable manure. Hot sun is injurious to them.

Hardy annuals.—Thin hardy annuals sufficiently to allow room for proper development. The thinnings, if withdrawn carefully from moist soil and transplanted at once, will take hold quickly, and flower beautifully.

Hedges.—Clip privet and evergreen honeysuckle hedges, removing the growth that has developed since April. Always work backwards to keep the part clipped in view. This affords a valuable guide to a neat clip.

Polyanthuses.—Divide flowered polyanthuses and set the divisions in a shady border at 9 in. apart. Here, if dusted at three weekly intervals with weathered soot, they will make splendid clumps for flowering next spring.

July.—If white leaf blotches appear on roses, dust them thickly with a mixture of 2 parts flowers of sulphur and 1 part freshly slaked lime. The trouble is mildew, a disease that spreads quickly, and ruins flowering prospects.

Sweet peas.—Remove side shoots from sweet peas, and where the plants are tied to stakes, the tendrils from the leaf ends. From now until the end of the season feed weekly and alternately with quarter strength liquid manure (1 gall. per yd. run), and sulphate of potash (1 oz. per yd. run).

Violas and pansies.—Remove faded flowers from violas and pansies weekly from now to the end of the season. A light mulch of leaf mould or lawn mowings, by conserving moisture, increases the output of bloom.

Lupins and delphiniums.—When lupins and delphiniums finish flowering cut off the faded spikes and yellowing leaves, feed weekly with dilute liquid manure, and there will soon be a charming second display.

Philadelphuses and diervillas.—Prune philadelphuses and diervillas as soon as they finish blooming. Cut out the flowered branches back to the point at which strong young shoots arise as these are the next season's flowers.

Hardy annuals.—Sow quick growing hardy annuals such as candytuft, calendulas, nemophilas, and saponarias for an autumn display. There are plenty of vacant spots in which these flowers will be welcome. Broadcast the seed thinly in well-worked soil, and just cover it by light raking.

Gladioli.—If slugs are crawling up the flower stems, prevent their ascent by wrapping a strand of cotton wool around the base of each stem 1 in. above the soil level. Water gladioli copiously during dry weather.

Lawns.—Give the lawn its summer dressing,—1 oz. per sq. yd. dose of a mixture of 3 parts sand and 1 part sulphate of ammonia. Water the dressing in.

Border carnations.—Layer border carnations. Choose healthy young shoots, strip the leaves from the bottom inch of the stem, make a longitudinal slit in the stripped part and plant the layers, while still attached to the parent, in a 4 in. high mound of sandy soil, securing them firmly with hooked wood pegs. In eight weeks the layers will be rooted, and ready for transplanting.

August.—Transplant wallflower seedlings into nursery beds at an all-round distance of 6 in. apart. Make the soil moderately rich, and very firm, to encourage sturdy growth.

Dwarf roses.—When the first wave of dwarf roses is past, cut the flowered shoots half-way back, to induce the development of strong side shoots which will bear a beatiful late summer and autumn display.

Madonna lilies.—Plant the Madonna lilies (*Lilium candidum*) in a warm sunny border. Space the bulbs 6 in. apart and bury the crowns or tops 4 in. deep. Colonies of three or four set at suitable intervals in the herbaceous border make a delightful picture.

Geraniums.—Insert cuttings of bedding geraniums 2 in. apart in boxes of sandy soil, or in 3½ in. pots (three cuttings round the side of each). Prepare each cutting for insertion by removing the two bottom leaves, and cutting across the stem immediately beneath the bottom joint. The ideal length for the cuttings is 2½ in. After watering, stand the vessels on a semi-shady path to root.

Pink pipings.—Insert pink pipings, which are 2 in. long shoot-ends pulled out, not cut off. Without any trimming, plant the pipings 4 in. apart in a sandy border.

Weeding.—Weed summer flower beds, remove faded blooms, and cut out exhausted shoots. If golden feather is flowering, cut off the flower stems. If phlox Drummondi is straggling, peg down the shoots.

Jasmine.—Prune summer flowering jasmine (*Jasmine officinale*). Cut out the weak branches, and shorten the remainder halfway back.

Sweet peas.—Spray sweet peas vigorously with nicotine insecticide if thrips, small yellow or black torpedo-shaped insects, are feeding on them. Loosen the soil around the roots, and mulch with short stable manure.

Rambler roses.—Feed rambler roses with quarter strength liquid manure from the time the buds show colour until the end of the flowering period. Then there will be no locked buds. Give each average sized specimen 2 gall. at five day intervals.

Deutzias.—Prune deutzias, shortening the side shoots to within 2 in. from the base. Cut out entirely weak shoots, which often develop rather freely in the centres of these shrubs. Afterwards fork in a light dressing of stable manure as far as the branches stretch.

September.—Insert viola, calceolaria, and pentstemon cuttings in a well-drained 4 in. deep bed of sandy soil in a cold frame. In each case choose 2½ in. long, unflowered shoots. Prepare them for insertion by removing two or three bottom leaves, and shaving the stem immediately beneath the bottom joint. Plant firmly at 2 in. apart. Keep the lights closed until young growth indicates that roots have formed. Shade during bright sunshine.

Earwigs.—Trap earwigs amongst dahlias and border chrysanthemums by folding corrugated paper loosely round the top of each stake. Examine the traps daily, destroying the pests that are found feeding therein.

Dahlias.—Feed dahlias from early September until the end of the flowering season, at weekly intervals. Here is an excellent mixture:—superphosphate of lime 6 parts, sulphate of ammonia 2 parts, sulphate of lime and sulphate of potash 1 part each. Give each plant one teaspoonful per dose, sprinkling it evenly on the soil around the main stem, and watering it in.

Lawns.—Sow lawns in well-manured soil, and on a fine, firm, even surface. Use 1½ oz. of seed per sq. yd., and cover it with ¼ in. of riddled soil. Weed established lawns, cutting out plantains, hawkweed and dandelions with an old table knife. Into the hole vacated by each dandelion drop a pinch of sulphate of ammonia to kill the remaining portion of the tap root. Destroy daisies by dressing thickly with lawn sand, avoiding surrounding turf. Choose dry weather, for in wet weather the lawn sand has no killing effect.

Rambler roses.—Prune rambler roses as soon as the flowers fade. Cut out the flowered branches at the ground level if no young shoots arise towards their base. Where young shoots do arise, make the cut immediately above their point of origin.

Dwarf roses.—Spray dwarf roses with half strength Bordeaux Mixture as a safeguard against Black Spot Disease, which with the approach of Autumn may be very destructive. The mixture is available in paste form at most garden shops, only needing the addition of a prescribed volume of water.

Hedges.—Clip privet, honeysuckle and yew hedges, removing the young growth, and making a neat finish. Use sharp shears, and do not rear a ladder or any heavy object against the edge, or this will spoil the shape.

Snowdrops.—Plant snowdrops in the lawn, in borders, amongst shrubs and around tree trunks. Set the bulbs 3 in. deep and 2 in. apart. Mix plenty of leaf mould with the soil. In addition to the common kind, the larger Byzantine snowdrop is well worth planting.

October.—Pull up summer flowers such as snapdragons, nemesias, stocks, etc., and fill the beds and borders with spring flowering subjects. Before doing so, dig 1 ft. deep, and incorporate a moderate dressing of stable manure and bone meal. The following are the distances at which the various spring flowers should be planted:—wallflowers, 12 in.; polyanthuses, daffodils, hyacinths and Darwin tulips, 9 in.; early tulips, 7 in.; double daisies and forget-me-nots, 6 in.

Planting bulbs.—Use a trowel when planting all spring flowering subjects, and plant firmly, to reduce the risk of lifting by frost. Set bulbs double their own depths; that is to say, if a bulb measures 1½ in. from the crown to the root plate, the crown or top must be 3 in. below soil level. Beneath each bulb place ¼ in. layer of sand, to encourage healthy rooting.

Sweet Williams and Canterbury bells.—Plant Sweet Williams and Canterbury bells in their flowering quarters at an all-round distance of 10 in. apart. Choose a sunny situation, mix lime or lime rubble freely with the soil and take care not to bury the deeply sunken crown or growing point, otherwise the plants will perish.

Dahlias.—When dahlias are blackened by frost, cut down the stems to within 3 in. of the ground level. Lift the roots, wash them under a running tap and after drying them, store in sand in a frost-proof place.

Disposing of rubbish.—At this season a considerable quantity of rubbish accumulates. Burn anything which is unhealthy and store the ashes in a dry place for use later as a fertiliser. Chop up the remainder and mix it with stable manure, a 4 in. layer of each run alternately, and eventually the heap will provide a valuable compost for digging into the garden.

Irises.—Plant English, Spanish and Dutch irises at an all-round distance of 6 in apart. Mix well-rotted manure and sulphate of potash freely with the soil. Set the bulbs 3 in. deep.

Lawns.—Cease mowing the lawn after the first severe frosts. Oil the machine and store it in a dry place. If there are worm casts on the lawn surface, water with permanganate of potash solution 1¼ oz. in 2 gall. of water and 1 gall. per sq. yd. Collect and destroy the worms at once as this treatment does not kill them all.

November.—Cut down herbaceous border plants to within 3 in. of the ground level. Tie the stakes into bundles of convenient size, and store them away for use another year. Fork 6 in. deep between the plants and mulch with a 3 in. layer of well-rotted stable manure.

Border chrysanthemums.—Cut down border chrysanthemums, lift a few plants, set them in boxes, and winter them in a cold frame. Where such a structure is not available, bury the roots in a heap of small, weathered cinders, where they will be preserved from damping off and slug attack.

Montbretias and gladioli.—Lift montbretias and gladioli and after cleansing the bulbs, store them in boxes in a dry, airy frost-proof shed.

Lilies of the valley.—Stir into the lily of the valley bed a 2 oz. per sq. yd. dressing of bone meal, and mulch with a 2 in. layer of equal parts well-rotted manure and leaf mould.

Roses.—Plant roses in moderately manured soil. Space dwarf, large flowered varieties 18 in. apart; dwarf polyanthas 15 in.; climbers and ramblers 6 ft.

Hedges.—Privet is the most satisfactory hedge to plant in exposed situations and poor soil. Set the plants in a double row at an all-round distance of 9 in. apart. The evergreen honeysuckle makes a beautiful hedge in a sheltered situation. Plant in a single row at 1 ft. apart. Lovely flowering hedges are made by Olearia Haastii (white), Berberis Darwinii (orange), and Escallonia Langleyensis (pink). Plant in a single row, with the leaves or branches just touching.

Winter aconite.—Plant the beautiful yellow winter aconite (*Eranthis hyemalis*) which blooms in early January. Set the roots 1 in. deep and from 2 to 4 in. apart. Informal planting is the most attractive, and there is no position in which winter aconites look lovelier than beneath the branches of a tree or shrub.

Frost.—Frosts are now becoming severe. If wallflowers, polyanthuses, forget-me-nots and double daisies are lifted by them, refirm the roots at once, otherwise they will perish through lack of soil contact.

December.—As soon as rose leaves fall, rake them up and burn them, together with the faded blooms. Fork 6 in. deep between the bushes, taking care not to injure the roots. Work in a 3 oz. per sq. yd. dressing of basic slag, the finest of all winter fertilisers for roses.

Lawns.—Lawns may now be laid with turf, which is the quickest means of establishing a lawn. Manure the soil liberally, and after making it fine, firm and even, spread 1 in. layer of sand or cinders on the surface, and lay the turf on that. Having done so, fill the cracks between the turves with fine soil.

Glass frames.—Wash the glass of frames in which bedding cuttings are planted. On frosty nights cover up calceolarias and pentstemons, or they will be seriously injured. When ventilating these frames, always tilt the lights on the leeward side, to exclude draughts.

Ivy.—Plant golden and silver ivy alongside shady walls and fences. Set the plants 6 ft. apart, and mix plenty of lime rubble with the soil. Insert 6 in. long ivy cuttings 3 in. deep and 6 in. apart in a shady border.

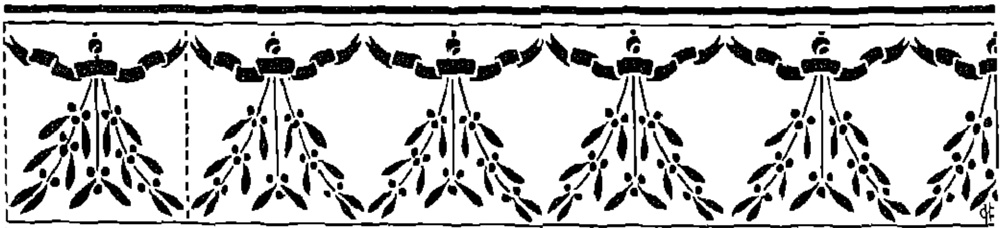
Alterations and improvements.—Make essential alterations and improvements, such as thinning shrubs, erecting rustic arches and fences, giving curves to straight borders, making an arbour and so on. Gardens that are quite plain can be made beautiful by artistic touches such as these.

Stored dahlias.—Examine stored dahlias, cutting off decayed tubers, and cutting out partially decayed pieces. If the tubers are shrivelling, sprinkle them with water, and they will soon plump up.

Christmas roses.—Stir into the soil around Christmas roses a dressing of superphosphate of lime to invigorate rooting and help the development of perfect flowers. After buds show, protect the plants with a glass-covered box to preserve unsullied the snowy whiteness.

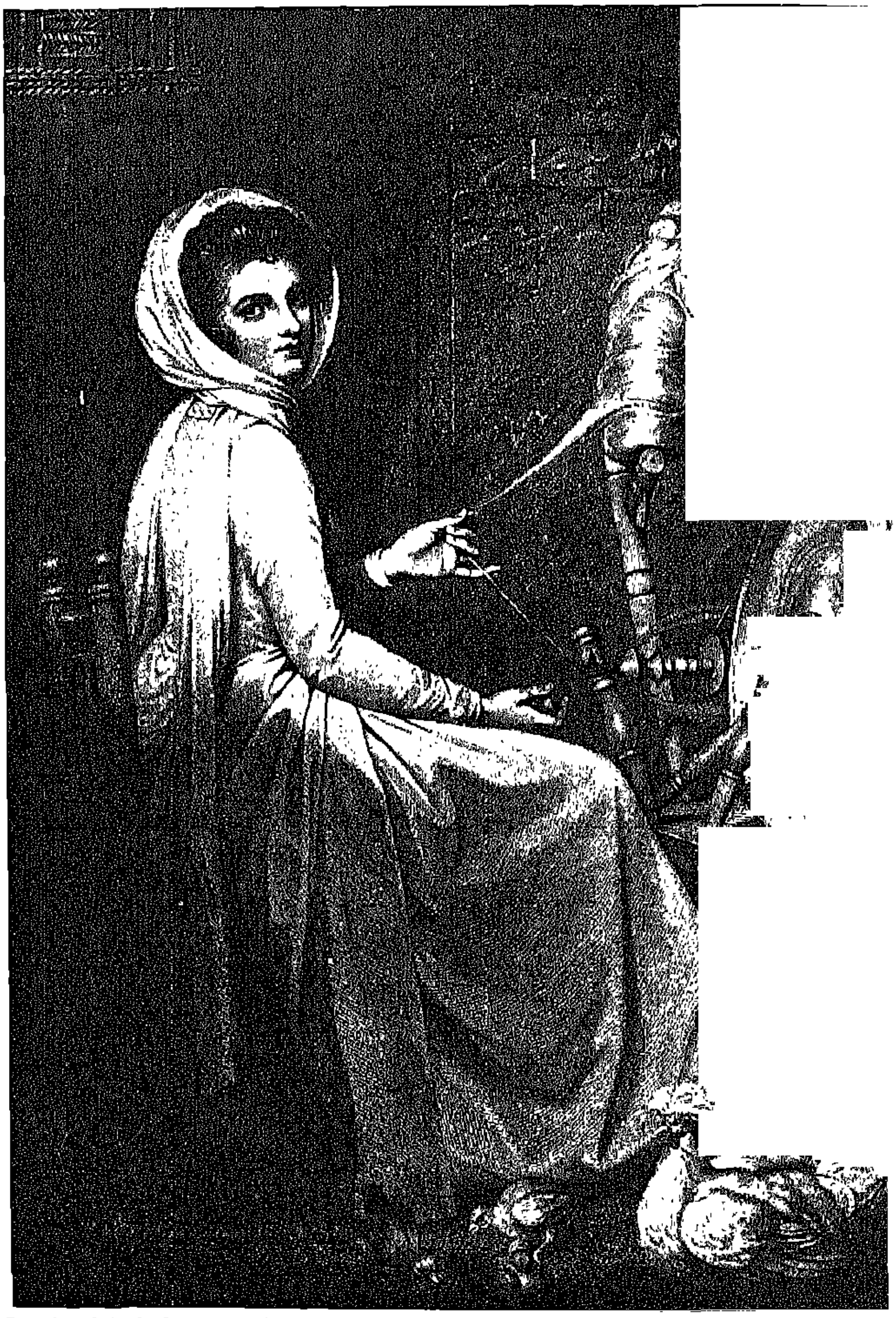
Evergreens.—When cutting evergreens for Christmas, consider the shrubs first. Remove only straggling and badly placed shoots. Cut them off cleanly, or the process will be followed by serious die-back.

Rockeries.—Clean up the rockery and replace displaced stones. If there is to be stability, each stone must be buried at least half its depth, and must tilt slightly backwards, to conduct water to the plants and not away from them.



A THREE YEARS' COURSE OF NEEDLEWORK

This Article is followed by THE MOTHERCRAFT COURSE OF NEEDLEWORK, *which* begins on page 333



From the painting by George Romney] *[Photo: W. F. Mans*

Lady Hamilton at the Spinning Wheel

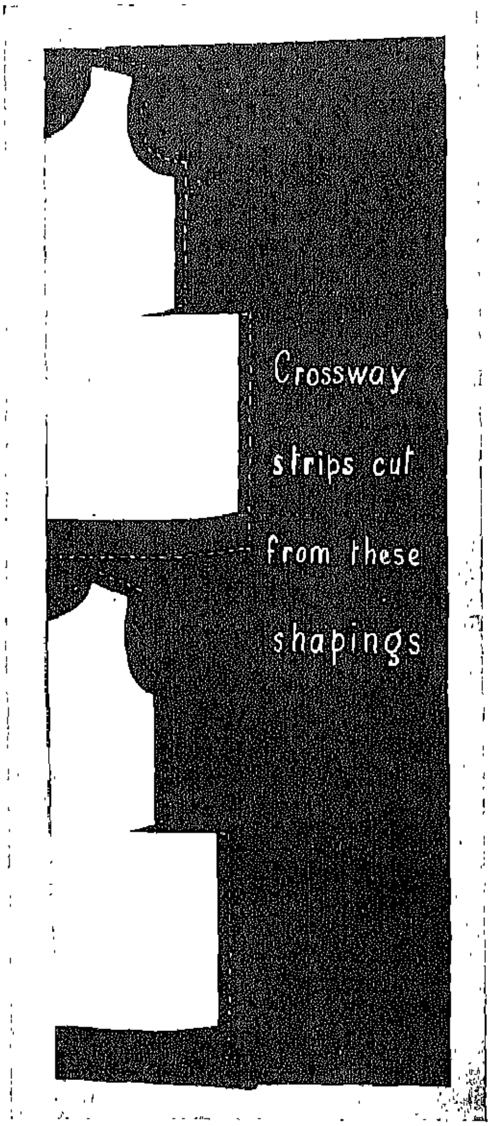
GENERAL INTRODUCTION TO THE THREE YEARS' COURSE

IT is taken for granted that pupils entering the senior school possess a reasonable knowledge of the use of the common tools necessary to a needlewoman; viz., scissors, tape measure, thimble. Everything attempted in the junior school should have had a direct bearing on, and given practice in, all the operations necessary for a pupil to cut out and make up her own garments, so that the teacher in the senior school justifiably looks for a certain standard of attainment in her pupils.

The instinct of needlecraft is a natural heritage of the female sex, and though there will be many cases where a girl is not gifted to specialise in needlework, a certain minimum is required by all, and knowledge of the subject is essential. What girl can foresee, when she fulfils her ultimate vocation in life of a "home-maker," whether her means will be limited or not? Every girl, on attaining school-leaving age, ought to be able to make a complete set of indoor clothes for herself and possess such a knowledge of needlework as will enable her to secure those additions to the home that will add to its beauty and comfort, which would otherwise be denied her.

Patterns.—The importance of a pattern is not so much in its actual production—patterns can be very easily obtained nowadays—but in the building up of the pattern which is the means by which pupils acquire knowledge of "proportion and line," without which the "cut" in a garment is non-existent, and the appreciation of the principle on which the pattern has been constructed is the salient point. The teaching of pattern making in senior schools should be based on the drafting of patterns and the use and adaption of bought or existing patterns. The use of ready-made paper patterns is essential, as these patterns, being well cut and up-to-date in style, have become very popular. They are extremely valuable as regards the fashions of the moment, and if the principles of pattern making, with which the pupil has become so familiar with constant use, are brought to bear on these patterns, there will be no difficulty in altering one's own "block" pattern to suit the details of fashion. However good a bought pattern may be, it may require adjustment. Existing patterns are cut according to the bust and hip measurements for normal figures, but this does not necessarily mean that the pattern will fit perfectly if the bust or hip measurement is correct, as all figures are not proportionate. The pattern should be tested with the wearer's own measurements, and the necessary adjustments made. The teacher must take particular care to notice that all alterations, which must be carried out by the pupils themselves, preserve the lines of the pattern to prevent the garment from being robbed of its smartness.

Computation of cost.—During the discussion on the garment to be made, the probable cost should also be discussed by the teacher. Patterns of the various kinds of materials suitable for the garment should be exhibited, the different widths with their accompanying prices per yard, and their suitability for the pattern should be explained. Reference must be made to the folding of the material to avoid waste and the best way of placing the pattern on it. The quantity of material required can then be calculated. Each pupil may then make her own choice according to the means at her disposal.



LAY OF THE PATTERN

Materials.—The adolescent girl has a natural longing for fashionable clothes to wear, and this finds expression to a certain extent in the choice of material when a new garment is under discussion. As the present day offers such a wide variety of materials in texture, design and colour, and the needlework stock cupboard is of necessity limited in its range of materials, girls should be encouraged to bring their own materials. This enables them to satisfy their desire in every way, and relieves the teacher of much anxiety as regards the sale of the garment.

Cutting out.—The difficulty of the cutting-out process varies in a lesser or greater degree according to the equipment of the classroom. Every available space providing a flat surface must be utilised in order to allow as many girls as possible to cut out at the same time, thus preventing the spending of too much time on one process. The pinning of the pattern on the material, the position of the worker, and the method of using the scissors must be demonstrated. The cutting out of the garment is best explained by means of a chart made by the teacher showing the "lay of the pattern on the material," the "material" in question being brown paper cut to represent material of various widths, and the pattern being cut out from drafting paper or brightly coloured paper. Much practice is needed in cutting out for the girls to gain confidence. Newspapers pasted together provide suitable "material" for practice in laying on the pattern and cutting out, whenever individual work is temporarily at a standstill. Following the instructions on the chart, the pupils will make similar "lays" ready for the teacher's supervision before cutting out.

Notebook.—It is advantageous to the pupils if they are provided with a notebook in which to make notes on the work done. This need not be an elaborate piece of work, but must be neat and tidy to serve as a reference for the pupil in future years. The notes could be made by one section of the class while the teacher is supervising the work of the remainder.

Output.—Waste of time is often the reason for a small output. To minimise this as much as possible, all materials should be given out before the lesson begins, so that work may begin at once. The garment should be started as soon as possible in the term. The teacher should aim at the production of three garments and a piece of knitting during the year. Girls lose interest in their work if the making of one garment is allowed to drag over the whole of the year. Waiting between garments should never be allowed. When three or four girls are ready, a new pattern should be taught. This gives recognition to quick workers and encourages the slower ones to speed up with their work. Much delay is caused by "unpicking" which spoils the work and discourages the worker. The teacher may avoid this by careful supervision of all fixing before the permanent sewing is done. Keeping all the girls fully occupied is essential if an increased output is to be obtained and interest maintained.

Methods of working.—Class teaching is of first importance in the teaching of needlework. Hitherto, this has been much neglected, most teachers being content to attend to *the pupils individually, telling them what* to do as each step arises. As a result the girls do not become self-reliant, and, although garments are produced, no training in garment construction is given. Some individual help will of course be necessary, but not until the principles of a process and the actual method of procedure have been taught the class as a whole. Group teaching follows in due course, short demonstrations being given to a group of girls as the need arises.

Teaching apparatus.—For class teaching to be efficient, good teaching apparatus is necessary. The teacher should provide herself with full-size drafts of patterns; bought patterns for comparison; full-size patterns for adaptations; mounted "lays" showing how to place patterns on material to the best advantage (dark paper should be used for the mounts and brightly coloured paper for the patterns); a completed garment attractively made up which has been made from the drafted pattern; giant apparatus for teaching stitches and processes (this consists of hessian or crash, coarse wools in vivid colours which can be seen by all the class, and a large upholstery needle); blackboard and coloured chalks to illustrate diagrams, and for making notes suitable for copying in notebooks; glass-headed pins which are more suitable for pinning apparatus to the board than the ordinary drawing pins.

The lessons given in detail in this volume are for class lessons dealing with the technical points of the work for each term. It is unnecessary to state how the teacher must apportion the work for the remainder of the time devoted to needlework lessons, as that depends on the proficiency of the class and the amount of work done in each lesson. It is expected that she will keep her pupils *fully occupied with the work suggested in* the scheme so that the scheme will be completed by the end of the term. In this course all the new processes involved in the making up of the garment are dealt with first, but in actual practice these lessons must be given as the need for each process arises.

Pressing.—The teacher must emphasise the necessity of pressing a piece of work when it is completed. After pressing, the finished appearance of the garment becomes much more pleasing to the eye, and the article looks a more perfect piece of needlework. Where a teacher has the necessary facilities and equipment she must teach the children by actual demonstrations how to press the work.

⁂

SCHEME OF WORK FOR A THREE YEARS' COURSE

FIRST YEAR

Pattern making.—Knickers; bodice; yokes.

Garment or article to be made.—Knickers; petticoat; drill tunic; needlework bag or linen bag; guest towels.

Knitting.—Caps; scarves; and gauntlet gloves.

Processes.—Eyelet holes; buttonholes; strengthening tapes; plackets or openings; gathers—setting in a band; machining; scalloping; pleating; neatening of seams.

Decorative stitches. — Herring-boning; feather stitching; simple embroidery stitches applied to household articles.

Repair work.—Simple patching for woollen and cotton underclothing and for dresses; darning; more difficult forms of patching.

SECOND YEAR

Pattern making.—The sleeve; cuff; collars.

Garment or article to be made.—Pyjama suit; gym blouse; nightdress with inset sleeves; duchesse set or luncheon set.

Knitting.—Jumpers.

Processes.—Setting in a sleeve; setting on a collar; setting on a cuff; machining; tucking; smocking and honeycombing; wrist openings; fastenings.

Decorative stitches.—Faggoting; stitches for application to household articles.

Repair work.—Darning for various kinds of household articles.

THIRD YEAR

Pattern making.—Block pattern of skirt and its adaptations.

Garment or article to be made.—Skirt; blouse or jumper; frock; chair-back covers; cushion covers.

Knitting.—Bathing suits.

Processes.—General revision of stitches required in dressmaking; machining; reducing fullness by means of darts; setting the skirt on a petersham band; turning the hem of a skirt; bound buttonholes; adaptation of bought patterns; neatening a neck line.

Decorative stitches.—Hem-stitching; rouleau work; stitches for application to household articles.

Repair work.—Care and use of household linen; adaptation and renovation of worn garments; repairing gloves.

⁂

FIRST YEAR COURSE—FIRST TERM

Pattern making.—Knickers.

Garment or article to be made.—Knicker garment completed; needlework bag or linen bag begun.

Knitting.—Cap.

Processes.—Plackets or openings; strengthening tapes; gathers—setting in a band; buttonholes; eyelet holes.

Decorative stitchery.—Herring-boning; feather stitching; daisy stitch; stem stitch and satin stitch.

Repair work.—Simple patching for woollen and cotton underclothing and for dresses; darning.

Discussion of work.—The first lesson in each term may well be spent in discussing the work for the term. During this discussion two completed pairs of knickers should be shown, one having the waist and legs gathered on elastic, and the other having side openings and the material gathered into bands at the waist and legs. (Although the latter style is rather old-fashioned, there are still many people who prefer the knickers to fasten on to liberty bodices instead of having elastic at the waist.) Attention must be drawn to the various stitches and the processes involved in the making up of these garments.

A needlework bag and linen bag offer suitable scope for the use of decorative stitches such as those included in the scheme, but these are merely suggestions and the teacher is not restricted in the choice of article so long as the stitches are carried out on the article or articles chosen. A completed decorative article must be exhibited.

It is essential that girls should have some knowledge of repair work. For garments to be cast aside because they are worn in one particular spot is wasteful. Many areas are feeling the effects of the industrial depression, and in these areas especially the need for prolonging the lives of garments is often imperative. This can be done if the worn parts are neatly repaired. As much care must be taken in the mending of garments as in the making of new ones.

A set comprising a cap, scarf and gloves will appeal to girls of this age as the knitted article to be chosen for the first year course. (Excellent instructions for the knitting of these articles are to be found in *2d.* leaflets which can be bought in any wool stores. These are quite easy for girls to follow who have had any experience at all in knitting.) The knitting must be started during the first term and continued throughout the year whenever a girl is waiting for the teacher's attention.

Time will probably allow after the discussion of the work for the garment itself to be considered, attention being drawn to its outstanding requirement; viz., that as it covers part of the trunk as well as the limbs, sufficient allowance must be made for freedom of movement of the joints. As the knicker garment consists of two parts, the body and the leg, some knowledge of the proportion of these parts is necessary in order to draft the pattern. For children's knickers the leg is equal to a quarter of the length; for girls' knickers a third of the length; and for women's knickers rather more than a third, but not half, of the length. The width of the leg depends on the style of the garment; e.g., if the leg is short it must be wide, or if the leg has to be gathered in a band or on elastic, sufficient allowance must be made in width for the gathers. The difference in the length of the front and back lines is due to an allowance being made for freedom of movement.

I. DRAFTING THE KNICKER PATTERN

Arrangement of lesson.—The teacher will demonstrate the drafting of the pattern on a large piece of paper pinned to the blackboard, the pupils working with her step by step.

Teacher's requirements.—A large sheet of plain white drafting paper cut to 1½ times the required measurements; coloured pencils; two blackboards, on one the draft of the pattern is illustrated, different coloured chalk lines denoting the folds of the paper and the pattern itself; on the other, the sheet of drafting paper must be pinned; glass-headed pins; a 3 ft. ruler; a finished garment; a drafted pattern; scissors.

Children's requirements.—A sheet of drafting paper; pencil; ruler; tape measure; notebook; scissors.

DEMONSTRATION

Measurements required.—Two measurements are necessary, the greatest length and the greatest width. The length may be measured from the side waist to the knee and one-fifth of this added to allow for freedom of movement, or an alternative method is to measure from the back waist to the knee with the leg bent at the hip point. One method may be used to check the other. The width of the knickers depends on the size of the wearer; e.g., for a child the width should be one-and-a-half times the length; for a girl it should be one-and-a-third times the length, and for a woman one-and-a-sixth times the length. The width may also be checked by measuring one-and-a-half times the hips and dividing by two. (This method should be adopted for children who are not of average size.)

Waist measurement for bands.—The average for a girl of eleven years is about 26 in.

Leg measurement for knee bands.—This is taken round the leg above the knee; the average for a girl of eleven years is about 14 in.

The girls must measure each other, the teacher afterwards confirming the measurements.

Drafting the pattern.—

1. Cut out an oblong in paper equal to the length and width measurements.

2. Fold widthways in two equal parts. Pin it upon a board keeping the fold to the left-hand side. Letter the corners ABCD, Fig. 1.

3. Fold the doubled paper in three equal parts lengthways and widthways and crease well. (Mark the creases with coloured pencil so that all the class can see them.)

4. Mark the position of the following letters:—

E = one division up from C for the length of the leg.

F = one division out from C for the width of the leg.

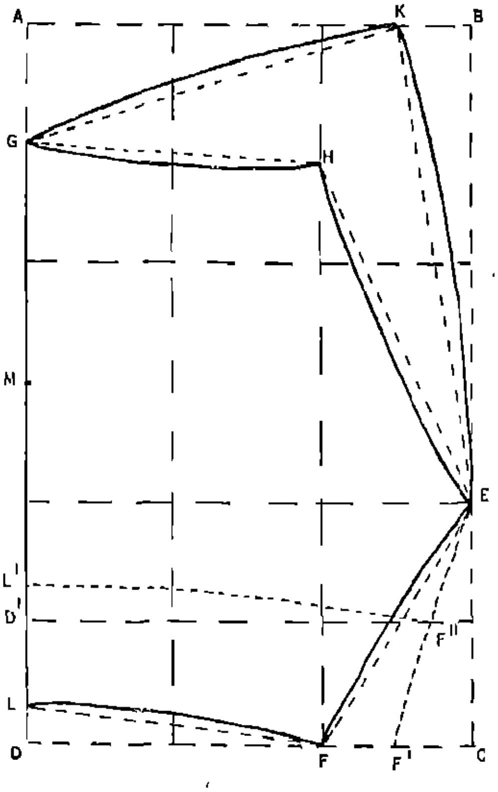


FIG. 1

G = half division from A.
H = ½ in. below G on the first division out from B.
K = half of one division out from B.
DL = 1 in. (to prevent the leg seam pulling up higher than the side of the knickers).
M = half of the second division down from A for the side opening.

5. Join GK and GH with straight dotted lines as guiding lines for joining the points with curved lines, Fig. 1. These form the waist lines of the knickers.

6. Join EH and EK with straight dotted lines, afterwards joining them with curved lines.

7. Join FE and FL in a similar manner.

8. L′ F″ denotes the shortened leg line for modern wear, which is also widened accordingly, D′ and F′ being half way in the divisions.

9. Cut out the pattern through the folded paper, passing through the points EFLGKE.

10. Cut through the points EHG on the upper layer of the paper only.

11. Draw an oblong for the front waist band equal to half the waist measurement plus 1 in. by 3 in., and another oblong for the back waist band equal to the front band plus 1 in. by 3 in. Cut out both oblongs.

12. Draw an oblong for the leg band equal to the leg measurement by 2 in. Cut out.

II. THE NEATENING OF OPENINGS

Although one or two girls only may require the teaching of this process in the construction of their knickers, it is as well to treat it as a class lesson, as openings occur in so many garments.

Aim of lesson.—To teach the pupils how to neaten openings, and the use and necessity of strengthening tapes.

Arrangement of lesson.—As the teacher demonstrates, the pupils will work with her on small pieces of material, making a sample of the processes taught. These samples serve two purposes: (1) they provide the pupils with an opportunity for practising a new process before carrying it out on their garments, thus helping to produce a higher standard of work than would otherwise be possible; and (2) they may be mounted in the notebook for any future reference.

Teacher's requirements.—A pair of knickers showing the first two methods of neatening openings; a sample of the third method; three large pieces of material for demonstration; different coloured pieces of material for the false pieces; coloured wools; needle; a chart illustrating the various stages in the neatening of the openings; pieces of coloured braid 1 in. wide to represent tape; pins; glass-headed pins; easel; blackboard; scissors; thimble.

Children's requirements.—Three pieces of material about 4 in. by 5 in.; strips of material, two 4 in. by ¾ in., one 4 in. by 1¼ in., one 4 in. by 1½ in.; needle; cotton; pencil; ruler; scissors; thimble; two pieces of narrow tape, one 4 in. long and the other 2 in. long; pins.

DEMONSTRATION

1. Pin the chart on to the blackboard; pin one large piece of material across the easel.

2. Pass round the class the knickers and sample for the girls to examine the various methods of neatening the openings, drawing attention to the use of the strengthening tape—to prevent a tear at the base of the opening.

3. The coloured strips of material for false pieces must be cut proportionately larger than the correct sizes.

METHOD I

1. Begin the first method by drawing a line down the centre of the material to

represent the opening. The girls must make their line 3 in. long. Cut down.

2. On the wrong side of the material on each side of the opening turn a narrow hem which tapers to a point at the base of the opening. Hold the hems in position with small hemming stitches (Fig. 1).

3. Fold a narrow turning on one end of the tape which is 4 in. long, and a similar turning on the other side of the tape at the other end.

4. Fold the tape in half, V-shaped as in Fig. 2, and lay it on the wrong side of the opening so that the inside edges lie to the folded edges of the opening, and the crossed portion of the tape falls to the base of the opening. Pin and tack in position.

5. Holding the right side of the garment towards you, sew from one end of the tape to the other, putting in several strengthening stitches at the weak corner. Slip the needle through to the wrong side and hem the tape down as far as the crossed tape. Where the tape overlaps, slip the needle along between the tape and the garment to the base of the opening, and hem the tape to the tape only, Fig. 2.

6. Continue hemming round the remainder of the tape and end off securely where the sewing began, Fig. 3.

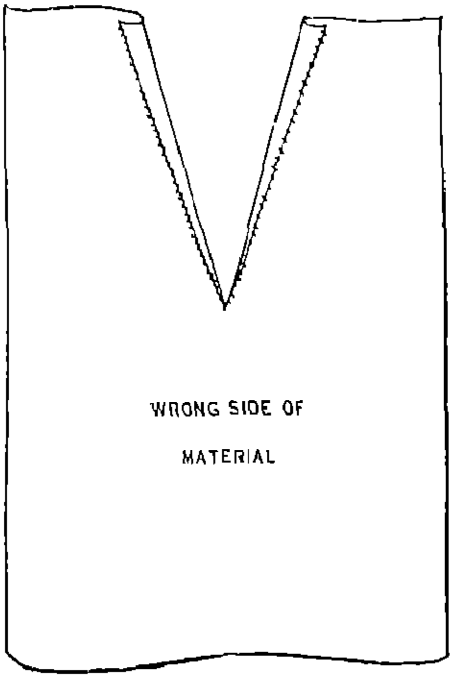


FIG. 1

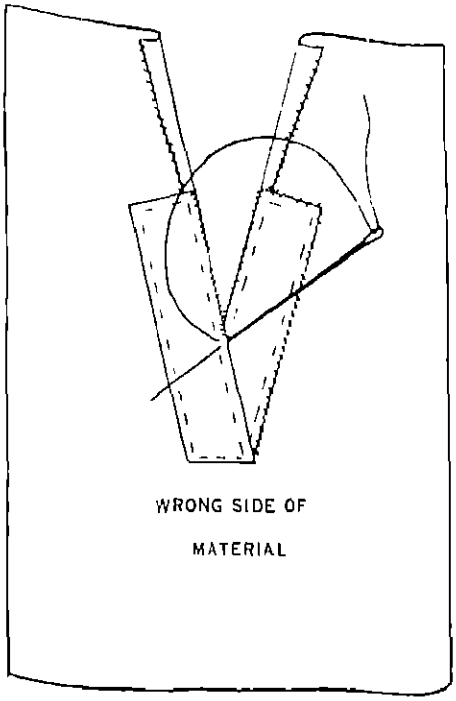


FIG. 2

Method 2

1. Cut down 3 in. in the second piece of material, and snip across the base at each side $\frac{1}{8}$ in.

2. Place the $\frac{3}{4}$ in. coloured strip to the side of the opening which will form the back portion of the knickers, having the right side of the material to the right side, and join the two together with very small running stitches to the end of the opening, Fig. 4.

3. Turn over the false piece to form a narrow hem on the wrong side of the garment, and secure it with hemming stitches as far

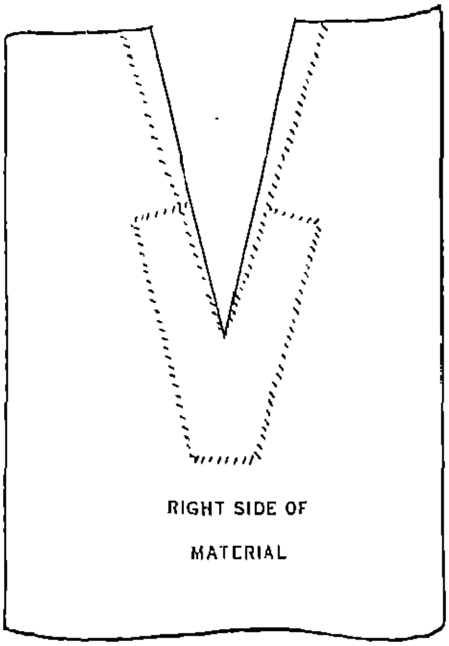


FIG. 3

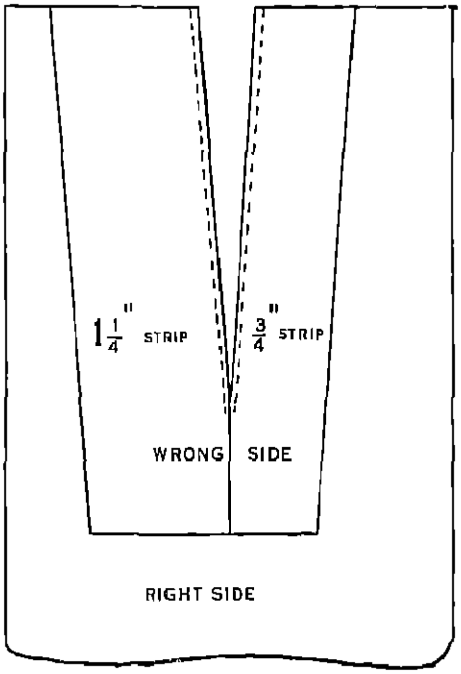


FIG. 4

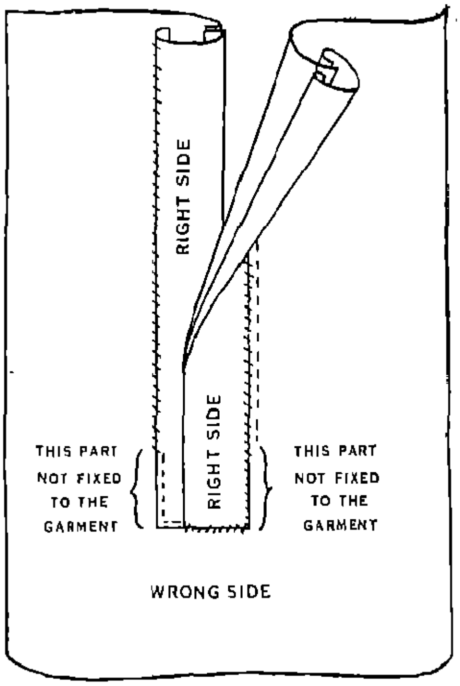

RIGHT SIDE
RIGHT SIDE
THIS PART NOT FIXED TO THE GARMENT
THIS PART NOT FIXED TO THE GARMENT
WRONG SIDE

FIG. 5

as the opening. Neaten the edges of the remaining portion of the false piece by turning a narrow lay inside, which is held in position with a running stitch (this is not caught down to the garment), Fig. 5.

4. Taking the 1¼ in. wide strip of a different colour, join it in the same way as the first strip to the opposite side of the opening with small running stitches.

5. Turn over the strip and double it back on itself to form a double fold which extends under the false hem on the opposite side of the opening. Turn in the edge, and hem down on the turnings of the previous join, having the turnings lying inside the folded portion, Fig. 5.

6. Neaten the edges of the surplus material lying beyond the base of the opening by turning in the raw edges to face each other and sewing them together, Fig. 5.

7. Fold over the hem on to the wrap so that the join of the false piece lies exactly over the join of the double fold, and hold

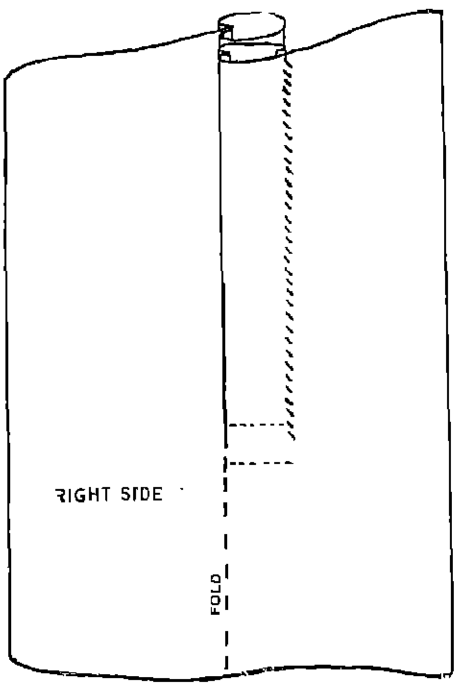


FIG. 6

the two together with two rows of stitching placed one above and one below the base of the opening, Fig. 6.

8. Cut a piece of tape long enough to cover the width of the false piece after a narrow fold has been turned at each end. Place this over the rows of stitching and hem it neatly down to the false pieces, taking care that the stitches do not show on the right side of the garment, Fig. 7.

METHOD 3

This method is the most difficult to carry out successfully, but it has a very neat appearance when finished, and, unlike Method 2, does away with the necessity for a fold at the base of the opening when completed.

1. Place the narrow coloured piece on the side of the opening which forms the front of the knickers, right side to right side, and join the two with a small running stitch, the turnings decreasing to a minimum at the base of the opening, Fig. 8.

2. Turn over the false piece on the wrong side of the garment, and form a hem ⅜ in. deep beginning at the base of the opening with the hemming stitches, Fig. 9.

3. Place the remaining strip to the remaining side of the opening, having the right side of the strip to the wrong side of the garment. Join the two edges as for the narrow piece, Fig. 9.

4. Raise the false piece and tack the turnings of the join flat so that they lie to the inside of the false piece, Fig. 10.

5. From the join measure ⅜ in. across the false piece, fold over and tack the fold in position. Across the false piece, from this fold, measure ¾ in., fold the remainder of the false piece under as turnings, and tack the fold in position. Turn under a ¼ in. turning at the base of the false piece, mitre the end by turning under the corners, and hold them in position with tacking threads, Fig. 11.

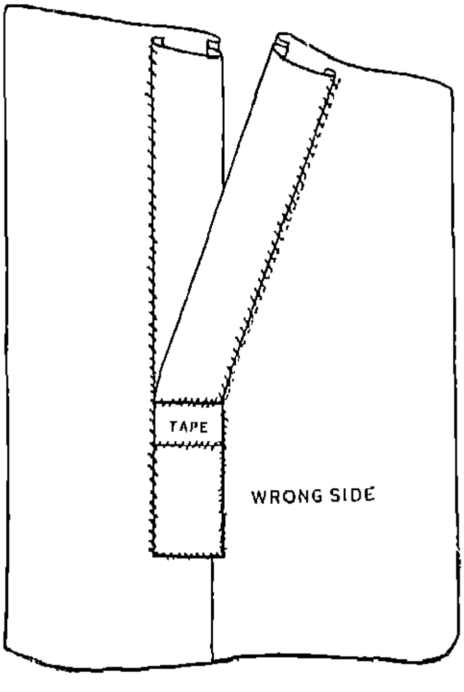


FIG. 7

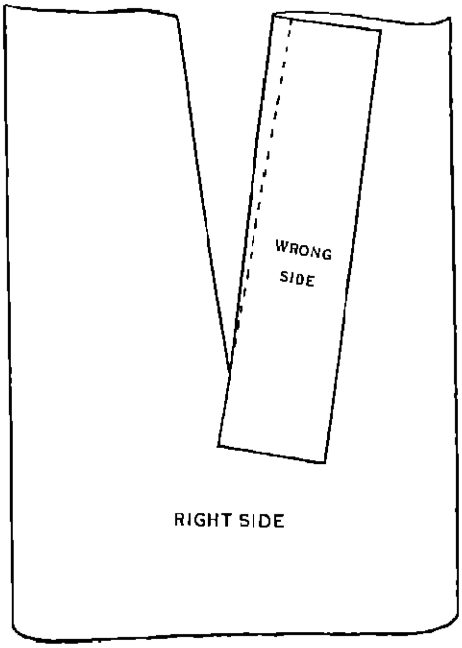


FIG. 8

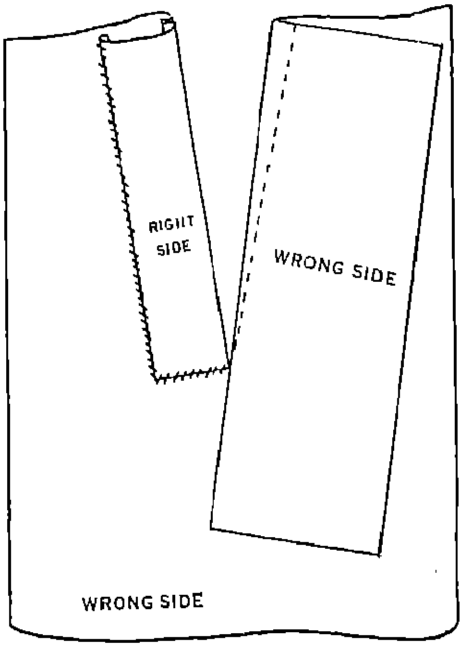


FIG. 9

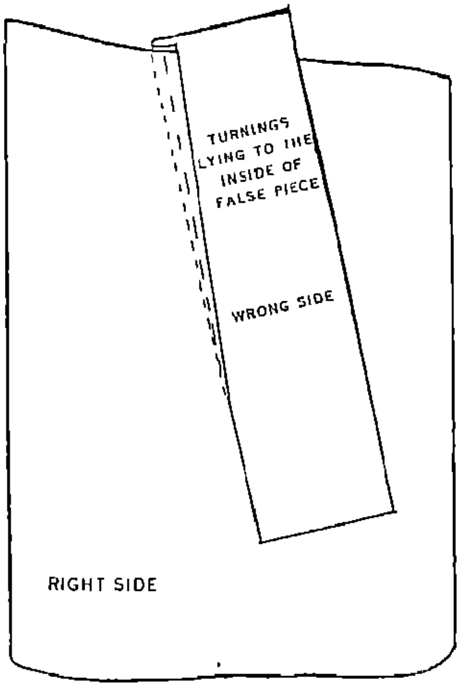


FIG 10

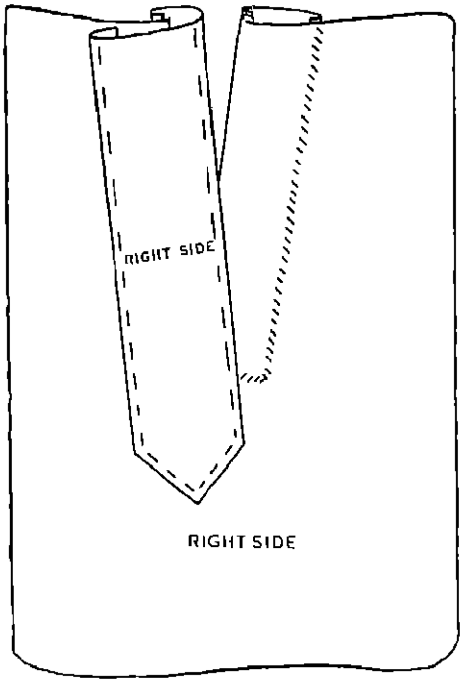


FIG. 11

6. Place the false piece in position over the false hem so that the two joins lie on the top of each other.

7. Stitch along the outer edge of the false piece only to within ¼ in. of the base of the opening, keeping the stitches close to the edge. Continue stitching the false piece through the garment along the mitred corner, and the remaining edge of the false piece. Place a row of stitching through both false pieces, ¼ in. above the base of the opening, Fig. 12.

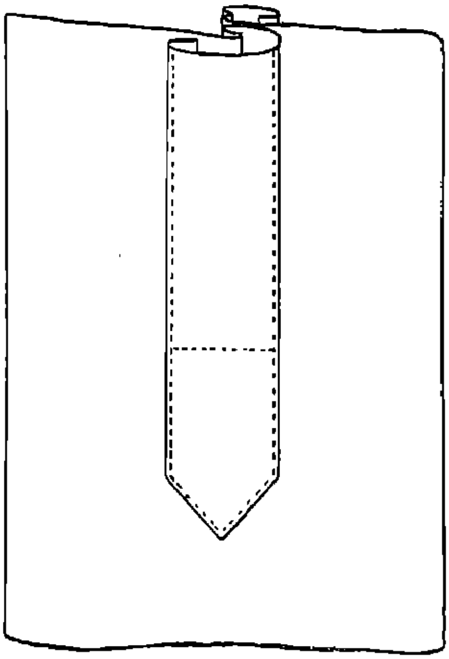


FIG. 12

8. Strengthen the base of the opening with a straight piece of tape on the wrong side as in Method 2. Remove the tacking threads.

III. GATHERING AND SETTING IN A CIRCULAR BAND

Reducing fullness in garments may serve two purposes; viz., to decorate a garment, and to allow freedom of movement. The methods of taking in fullness which will be dealt with in this course are (1) gathers; (2) pleats; (3) tucks; (4) smocking, and (5) darts.

Setting gathers in a band is one of the most difficult processes in garment making. Setting in a circular band has been chosen for the lesson as it is a more difficult operation than setting in a straight band, and will be needed if the legs of the knickers have to be gathered into bands. In a straight band the same rules are observed, but the work is easier to handle as the band is not joined.

Aim of lesson.—To teach the correct method of setting gathers evenly into a band.

Arrangement of lesson.—As in previous lessons, the pupils will work along with the teacher step by step. When the sample is completed it must be mounted in the notebook opposite the corresponding notes.

Teacher's requirements.—A pair of knickers having the legs set into bands; a large piece of material for gathering; a piece of coloured material to represent the band; coloured wools; scissors; thimble; needle; pins; sketches illustrating the various stages of the lesson drawn on the blackboard or on a chart.

Children's requirements.—Pieces of material 13 in. by 5 in.; piece of material for a band 10 in. by 1½ in.; needle; cotton; pins; scissors; thimble; darning needle.

Introduction.—Reducing fullness by means of gathers is the method generally used when dealing with very soft, fine fabrics which are suitable for washing, as the point of the iron will easily reach the ends of the gathers, and these materials when reduced do not appear bulky. The gathers are usually stroked, but if the material is such that it is unsuitable for stroking; e.g., crêpe-de-chine, then a double line of gathering threads will regulate the fullness better than one line, the stitches of both lines falling exactly under each other. In this case, the gathers are set in between the two gathering threads, the lower one being removed afterwards.

DEMONSTRATION

1. Prepare the band by turning down the short sides ½ in. on the wrong side of the material, placing the two short sides together, right side to right side, and joining them with sewing stitches.

2. Along each selvedge turn ¼ in. turnings on the wrong side and tack.

3. Divide one edge of the circular band into four equal portions and mark with tack stitches.

4. Join the large piece of material to represent the garment, and divide the edge to be gathered into four equal parts, the seam forming one of the divisions. Mark with tack stitches.

5. Turn down ½ in. turnings at the edge of the "garment" and crease well, the crease serving as a guide to a straight gathering thread.

6. Along this crease work a gathering stitch on the right side of the material using a coarser cotton than the one used for sewing, and leaving twice as much material between each stitch as is taken up on the needle. Leave a small portion plain on each side of the seam to avoid bulkiness. The thread must be long enough to work all round the leg without a join.

7. Draw up the cotton with the left hand, gathering the material between the forefinger and thumb on the right hand. This cotton must not be drawn up too tightly.

8. Place a pin upwards where the loose cotton passes out at the end of the gathering, and twist the cotton round the point and head of the pin, Fig. 1.

9. Hold the end of the "garment" with the left hand and pull down the "garment" with the right hand to make the gathers straight and even.

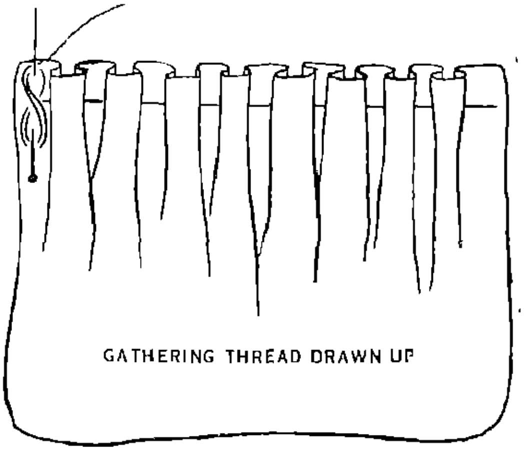


FIG. 1

10. Stroke the gathers, beginning at the pin with the material held between the left thumb and forefinger, and using the eye of the darning needle held in the right hand. The point of the needle must never be used or the material will be scratched instead of stroked, and the threads of the material will be weakened. Lay the needle flat in the groove between the first and second gathers, lift the first gather carefully with the whole length of the needle, place it under the left thumb and press it down firmly, at the same time stroking the eye of the needle down the groove for about ½ in., Fig. 2, p. 198. When there is no sound caused by the stroking, this process has been taught successfully.

11. Turn the "garment" round and stroke the gathers above the thread to make the setting in easier.

12. Draw out the pin and loosen the gathers until they fit the band. End off the cotton firmly.

13. Place the marked edge of the band just over the gathering thread of the "garment" on the right side of the material, laying the seam of the band to the seam of the "garment" and regulating the gathers so that the divisions of the garment meet the divisions of the band. Fix the

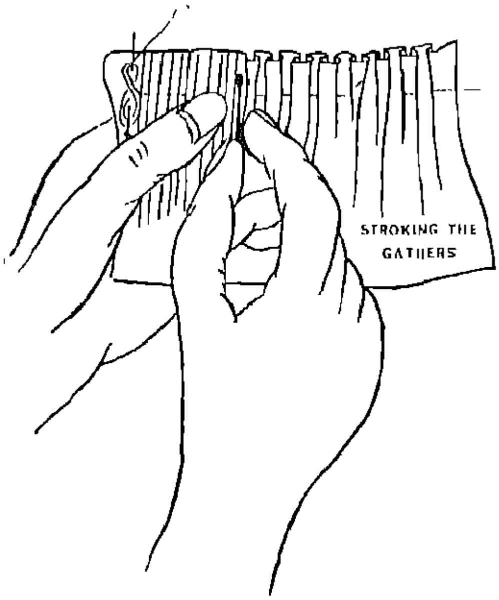


FIG. 2

band to the "garment" by means of upright tacking stitches on the right side and slanting stitches on the wrong side. This kind of tacking stitch holds the gathers in position more firmly than the ordinary tacking stitch, Fig. 3.

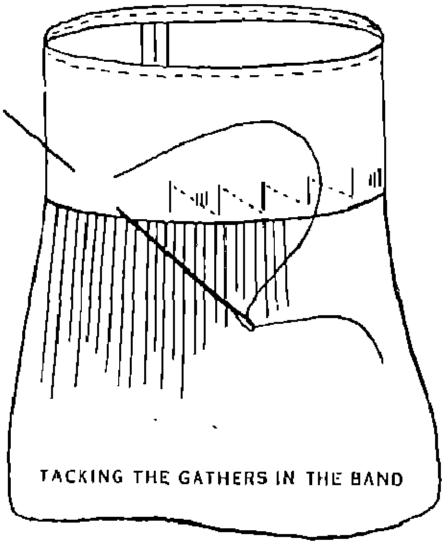

TACKING THE GATHERS IN THE BAND

FIG. 3

14. To set in the gathers, begin as for hemming and hem the plain part near the seam; then turn the work so that the left forefinger lies along the gathers. Place the needle horizontally through the first gather, just below the edge of the band, then turn the needle round and pass it through the edge of the band as for hemming, Fig. 4.

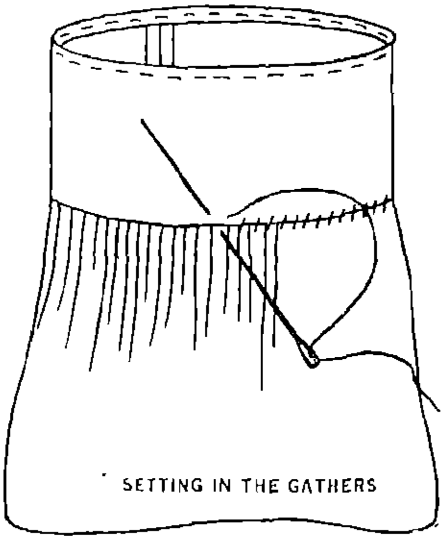


FIG. 4

15. Place the needle through the next gather as before, and continue along the band, lifting each gather and setting it in separately.

16. Turn the garment inside out, fold over the band to the wrong side and lay the edge just above the stitches showing through from the right side. Fix this in position with tacking stitches, taking care not to pucker the band. Set in the gathers in the same way as before, but do not allow the stitches to show through on the right side of the garment.

IV. BUTTONHOLES AND EYELET HOLES

Buttonholes present a rather difficult process and much practice is needed to achieve good results.

Aim of lesson.—To teach the pupils the use of buttonholes and eyelet holes; their position in a garment; and the correct method of working them.

Arrangement of lesson.—The pupils work samples while the teacher demonstrates, using pieces of material to represent a band.

Teacher's requirements.—Two pairs of knickers, one with the waist set into bands showing buttonholes, the other with the waist gathered on elastic showing eyelet holes; a large piece of hessian; coloured wools; needle; scissors; thimble; easel; drawing pins; pins; large button; chart illustrating the stages in the making and working of a buttonhole, and the different kinds of buttonhole; stiletto; chart showing the stages in the making of eyelet holes.

Children's requirements.—Pieces of material doubled and sewn at the sides to represent a band; cotton; needle; scissors; thimble; pins; button; notebook.

Introduction.—A buttonhole is always worked on double material. If it is necessary to work one where there is only single material, then a piece of tape must be placed at the back to strengthen it, Fig. 1.

Buttonholes are cut in the direction of the "strain" or "pull" on a garment, so that they usually lie in a horizontal direction at the ends of bands or on close-fitting garments, but in garments such as shirts, blouses and nightgowns, which are generally wide enough to cause no strain, they are placed in a vertical position, Fig. 2.

The method of working the ends of a buttonhole depends upon its position. When cut with the strain they have one rounded end and one square end. The round end is placed at the end of the buttonhole nearest the button, and allows the buttonhole to pass easily over the button, while the square end keeps the hole closed. Two similar ends are worked on vertical buttonholes, either round or square, preferably

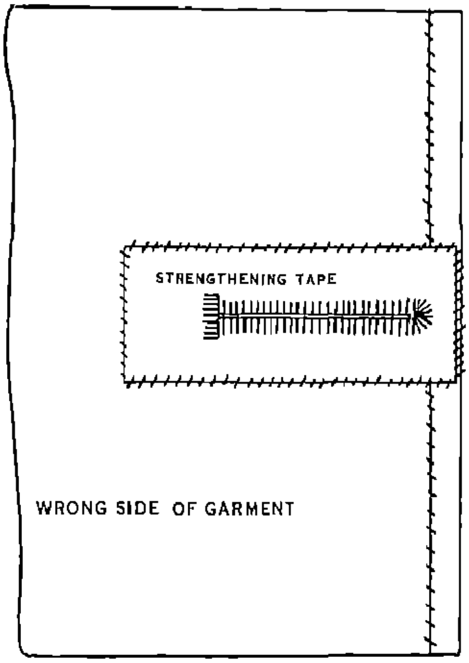


FIG. 1

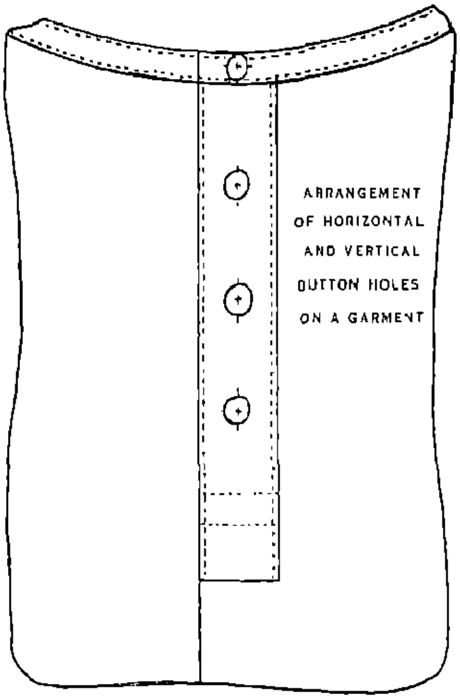

ARRANGEMENT OF HORIZONTAL AND VERTICAL BUTTON HOLES ON A GARMENT

FIG. 2

square, as these give a better appearance to the garment.

The thread used should be about the thickness of the threads of the material, and slightly coarser than the cotton used for sewing.

DEMONSTRATION

Cutting a buttonhole.—

1. The position of a buttonhole must first be determined; i.e., far enough away from the edge to keep clear of the turnings.

2. The length of the buttonhole is determined by the size of the button. Pin the hessian on to the easel. Place a pin at each side of the button to mark the diameter and allow $\frac{1}{12}$ to $\frac{1}{8}$ in. more so that the button will slip in easily. Draw a faint pencil line from pin to pin to indicate the position of the hole, Fig. 3.

3. Fold the material in the centre of the line and at right angles to it. Snip the fold with a sharp pair of scissors, open the material and cut along the pencil line through the double material as far as the pins at each side, Figs. 4 and 5.

On no account must a buttonhole be cut until it is ready for being worked, as the longer the hole is left the more frayed do the edges become, thus increasing the difficulty of working it.

Working the buttonhole—One round and one square end.—The buttonhole stitch differs from blanket stitch in having a firmer knot, and it is worked from the raw edge instead of towards it as in blanket stitching. The knots should lie flat along the raw edges.

1. Begin by slipping the needle between the folds of the material about ½ in. away from the end of the buttonhole farthest away from the edge of the garment, on the left side of the slot, and bringing it out on the wrong side close to this end of the buttonhole. Make two small back stitches through one thickness of material only, and bring the needle out to the right side as close to the raw edges as possible.

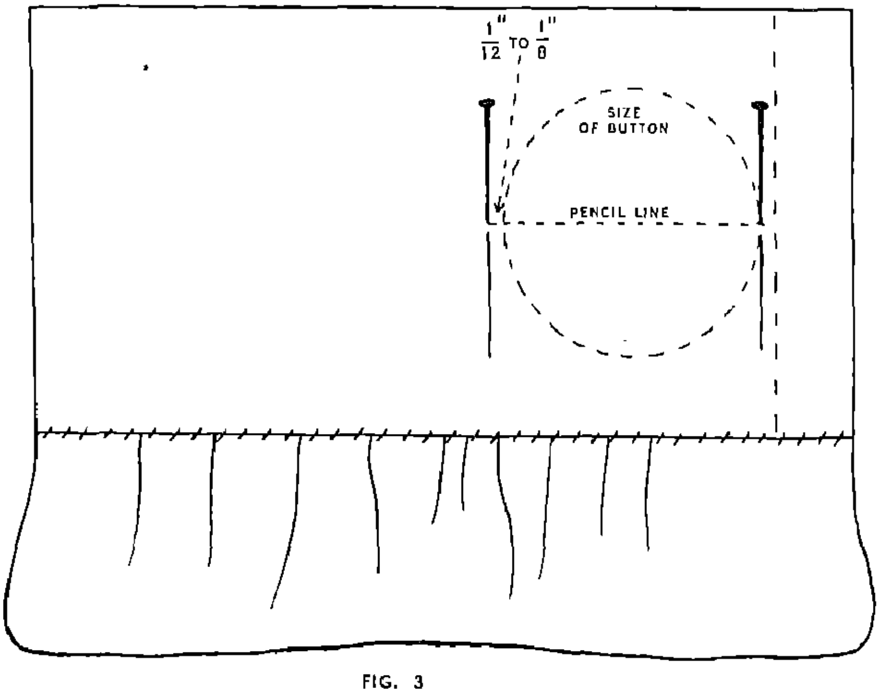


FIG. 3

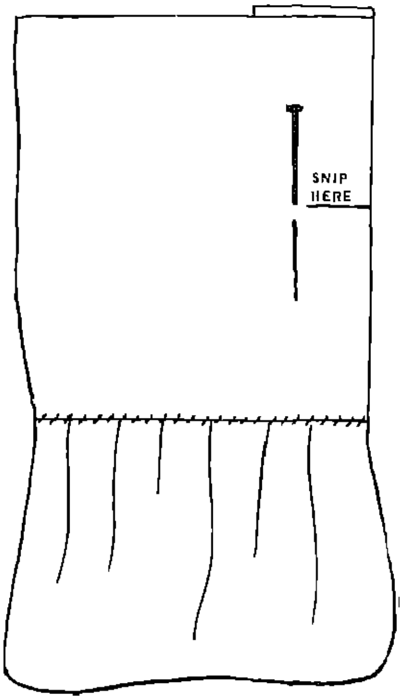


FIG. 4

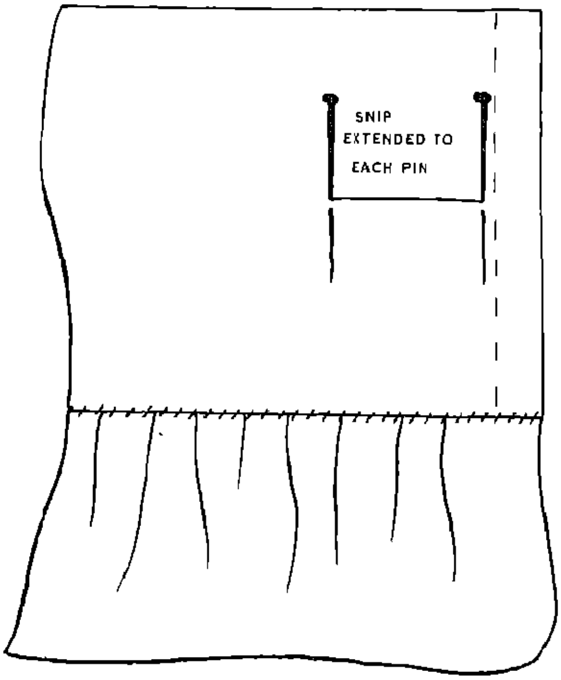


FIG. 5

2. Slip the needle under the raw edges, bringing out the point about $\frac{1}{8}$ in. away (the depth of the stitch should be about four threads). Place the double cotton from the eye of the needle round the needle point from right to left, Fig. 6, p. 202.

3. Draw the needle out towards the right, pulling the cotton so that the knot lies on the raw edge, Fig. 7.

4. Holding the material tightly between the left thumb and forefinger, so that the two edges of the buttonhole cannot stretch apart, work the buttonhole stitches along the left side of the hole, taking care that the stitches are of uniform length and are worked closely together. The cotton must be drawn up firmly and quickly so that the edge is knotted securely, Fig. 8.

5. Overcast the end of the buttonhole, making a semicircle of stitches, putting in nine stitches so that the middle stitch will lie in a line with the slit, Fig. 9. A good guide for keeping the stitches evenly spaced round the end is to trace the semicircle with the point of the needle, pricking the positions of the stitches through, half the semicircle being taken at a time.

6. Proceed with the buttonhole stitches along the second side, then insert the needle through the knot of the first stitch on the first side worked, and bring it out at the foot of the last stitch made on the second side, Fig. 10.

7. Make a strand across the length of the stitches on both sides by inserting the needle at the foot of the first stitch on the first side and bringing it out at the foot of the last stitch on the second side, Fig. 11.

8. Work buttonhole stitches over the strands, inserting the same number of stitches as in the round end, the knots falling towards the buttonhole, Fig. 12.

9. Pass the needle through to the wrong side close to the last stitch made, make two small back stitches through one thickness of material only, slip the needle through the

folds of the material for about ½ in. and cut off the cotton, Fig. 13.

Fig. 14 shows a buttonhole with two round ends, and Fig. 15 shows a buttonhole with two square ends. When working the latter both sides must be worked before the ends are begun.

When working the centre buttonhole in the waist band of the knickers a vertical buttonhole must be made with a round end towards the edge of the band where the strain of the fastening falls.

If possible, avoid making a join when working a buttonhole. If, however, a break

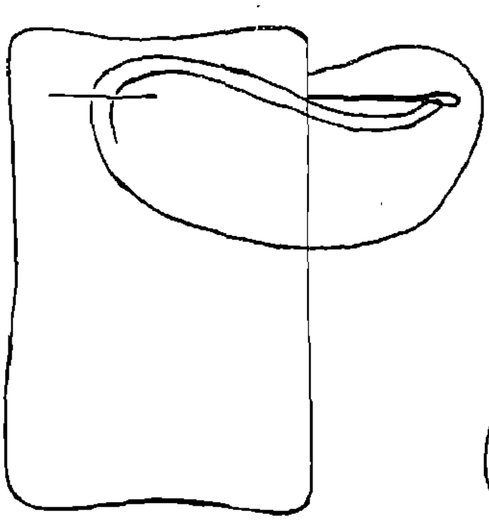


FIG 6

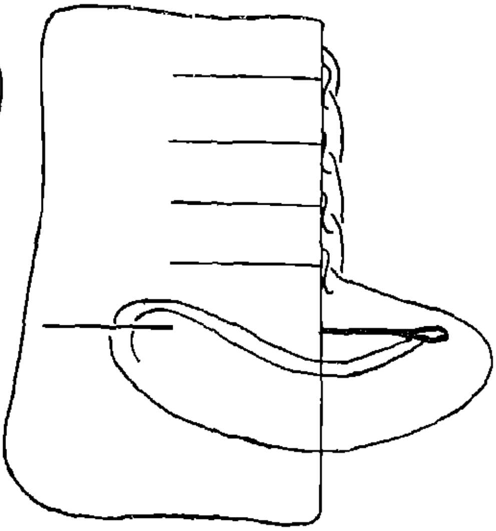


FIG. 7

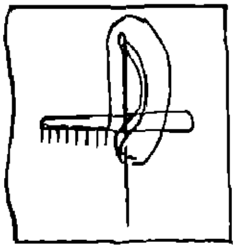


FIG. 8

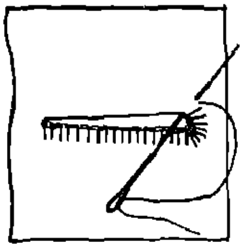


FIG. 9

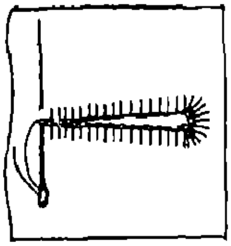


FIG. 10

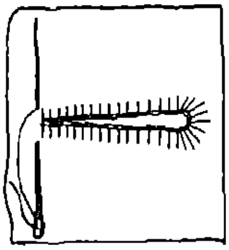


FIG. 11

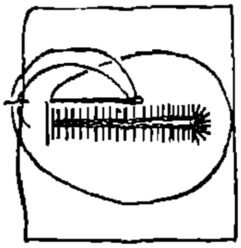


FIG. 12

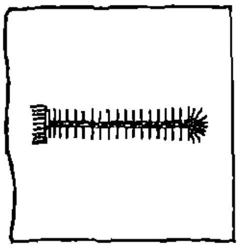


FIG. 13

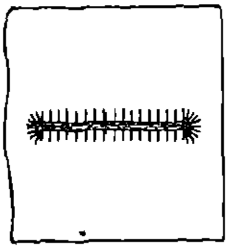


FIG. 14

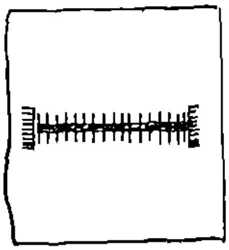


FIG 15

should occur, proceed with the join as follows:—

Cut the old cotton off to within ½ in. and ease the last knot. Insert the needle so that the new cotton comes out of the centre of the last knot, tighten the knot again and lay both short ends along the raw edge to be sewn down, Figs. 16 and 17.

Eyelet holes.—These are used for (1) holding hooks; (2) threading laces through to fasten an opening, or (3) for drawing cords or tapes through a slot. Eyelet holes are pierced with a stiletto, and the raw edges are neatened with sewing stitches (Fig. 1), blanket stitches (Fig. 2), or buttonhole stitches, Fig. 3, p. 204. For hooks and laces the eyelet holes are worked through double material; for draw-strings through single material.

Work the three ways of neatening eyelet holes on a piece of hessian, the girls working the same on one of their "bands."

BRIEF INSTRUCTIONS FOR THE CONTINUATION OF THE KNICKER GARMENT

Computation of cost.—Kinds of material; widths; prices per yard; quantity required.

Cutting out.—Lay the pattern on the material as in the diagram and cut out allowing ½ in. turnings. (The teacher's mounted lay for demonstration purposes should be as in the diagram.) Remnants of material after cutting out should be kept in the "rag-bag" for use in making samples.

Brief notes on the draft of the pattern and the making up of the knickers must be made in the notebooks whenever opportunity affords.

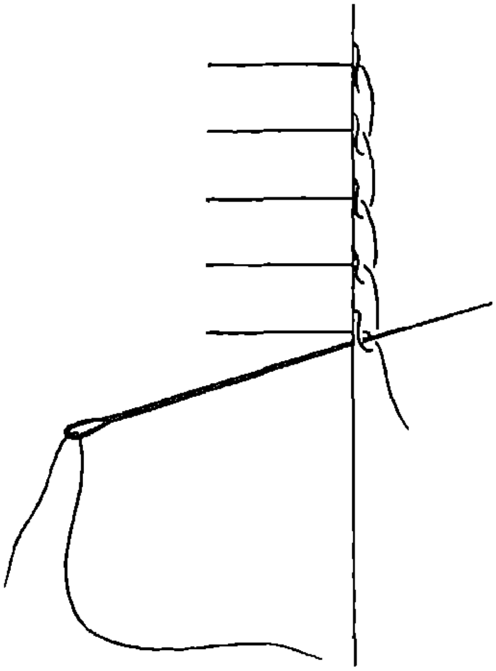


FIG. 16

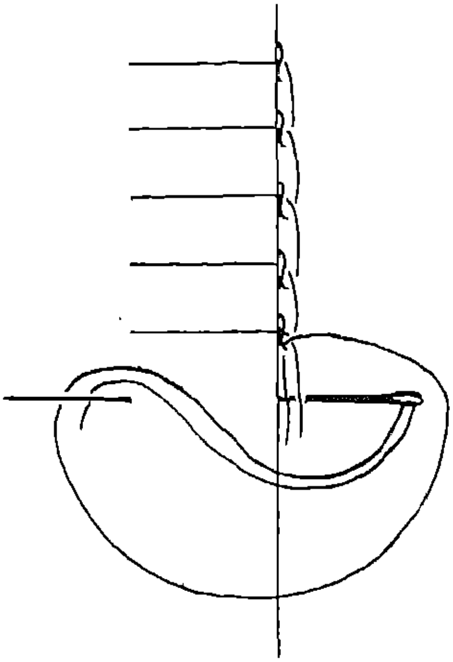


FIG 17

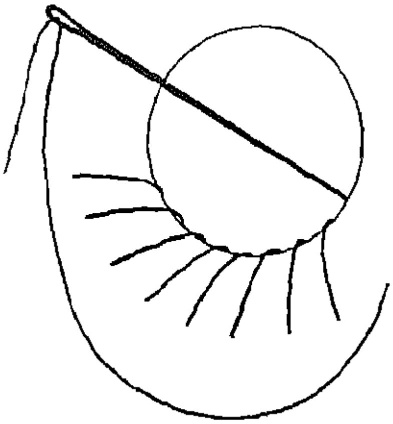


FIG. 1

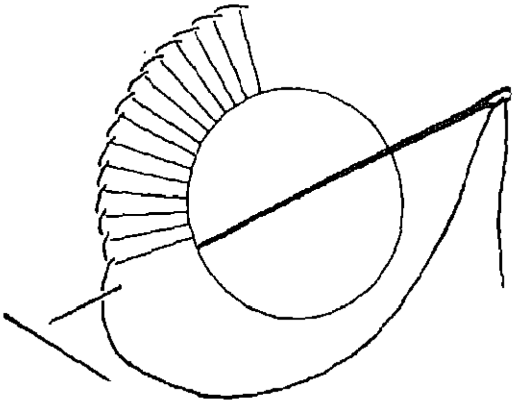


FIG. 2

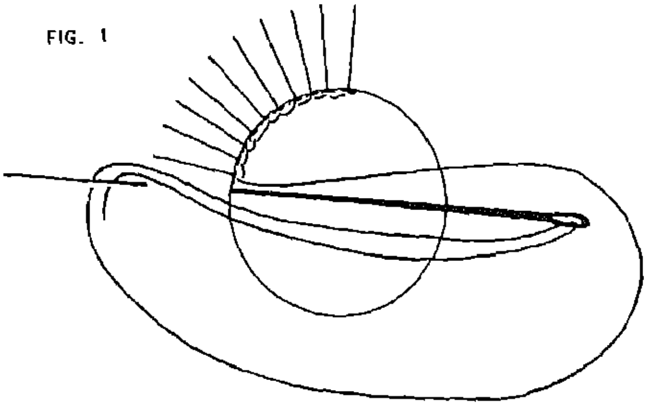


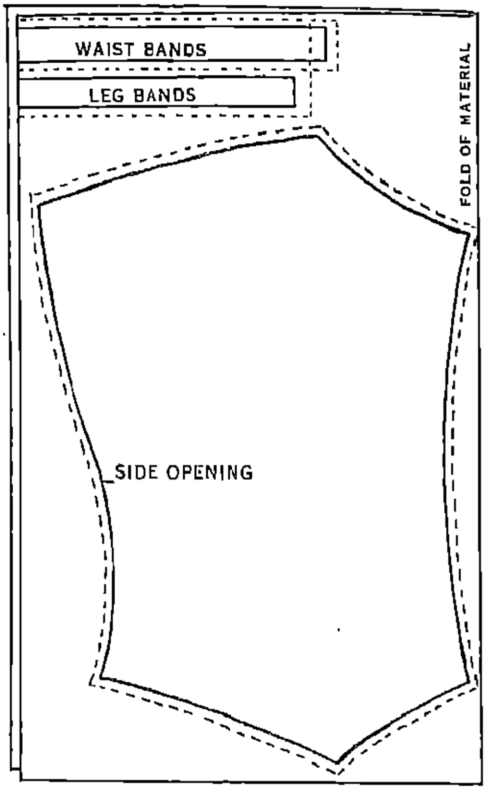
FIG. 3

Making up the knickers.—Pair the legs for left and right, and complete each leg by joining with a French seam. Face the bottom of each leg, make eyelet holes and insert elastic, or gather the bottom of each leg and set into bands. Join the two legs together with a French seam, commencing the sewing each time at the "fork" where all the four seams meet. Face the waist of the knickers with a crossway strip, afterwards making eyelet holes and inserting elastic, or neaten the side openings, and set the front and back waists into bands, afterwards making buttonholes. If elastic is inserted, it should be made to fasten with a loop and button so that it can easily be removed for washing purposes.

The legs of the knickers may be embroidered with a simple design in order to give the garment a daintier appearance. If desired, run and fell seams may be made instead of French seams.

V. DECORATIVE STITCHERY

Embroidery, or the decorative side of needlework, enables the love of beauty in colour and design, inherent in everyone, to be expressed in the home. Household articles, presenting a dull and common-



Lay of the Pattern

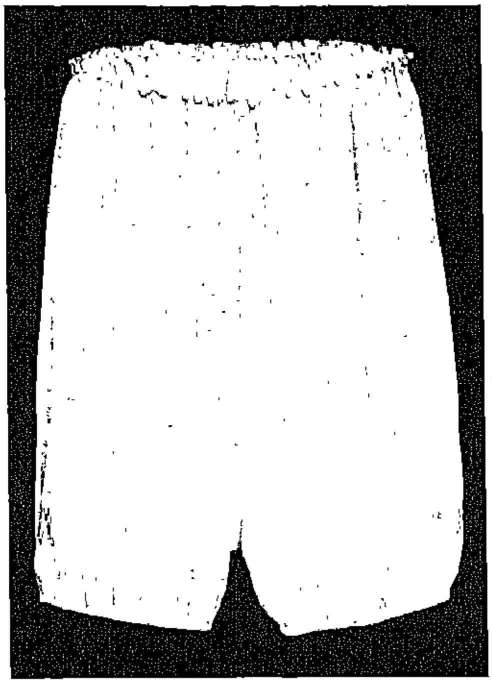
place appearance by their monotonous surfaces, become transformed by means of decorative stitchery into beautiful and attractive articles. The stitches already practised and those to be learned may be grouped to form pretty borders and *motifs* of varying shapes suitable for decorating parts of articles of household use. Special attention must be given to the mingling and blending of colours, and the material with which the embroidery is carried out; viz., embroidery cottons, silks or wools, the medium used depending entirely on the kind of material and the purpose for which the article is intended.

The new stitches suggested for this term are feather stitching; herring-boning; daisy stitch; stem stitch; and satin stitch. Two articles appropriate for the illustration of these stitches are a needlework bag or a soiled linen bag.

Aim of lesson.—To extend the pupils' knowledge of decorative stitchery, and to encourage a love of beautifying commonplace articles.

Arrangement of lesson.—While the teacher demonstrates the making of each new stitch the girls follow her instructions on a piece of crash, which can be fixed in the notebook later and used as a sampler.

Teacher's requirements.—Charts showing the different stages in the working of the various stitches; suitable designs from which the girls may choose the decoration for their own article; large pieces of crash; a large piece of canvas; coloured wools; needle; scissors; thimble; easel; a needlework bag and linen bag showing the application of these stitches; illustrations of the new stitches drawn in bold sketches on the blackboard in coloured chalks; drawing pins.



Embroidered Knickers with Elastic at Waist and Legs

Children's requirements.—A piece of canvas; piece of crash; embroidery cottons or wools; needle; thimble; scissors; notebook.

DEMONSTRATION

Feather stitch.—It will be found much easier to teach the working of feather stitch on canvas instead of cloth material, as by counting the threads there is no necessity for the pupils to gauge the length of each stitch until they have mastered the process. When this has been done, the continual practice of making the same length of stitch will help them to gauge the distance when working on cloth materials. The stitch is worked in vertical lines at equal distances to the left and right of an imaginary vertical line.

1. Pin the piece of canvas across the easel. Begin at the top left-hand side of the imaginary vertical line by passing the needle through from back to front and leaving about 4 in. of cotton underneath, which is darned in at the back of the stitches afterwards.

2. Curve the cotton round to the right to form a loop, which is held beneath the left thumb.

3. Insert the needle two threads to the right in a straight line and bring it out over the loop two threads downwards in a *straight line*, *Fig. 1*.

4. Pull the needle through, allowing the loop to slip from under the thumb when the cotton is almost drawn through.

5. Curve the cotton round to the left to form a loop, which is held by the left thumb.

6. Insert the needle two threads to the left in a straight line, and pass it over the loop two threads downwards in a straight line, Fig. 2.

7. Continue working the stitches from left to right alternately. From this practice the pupils will gradually realise and build up for themselves the rule that each new stitch must commence on the same level as

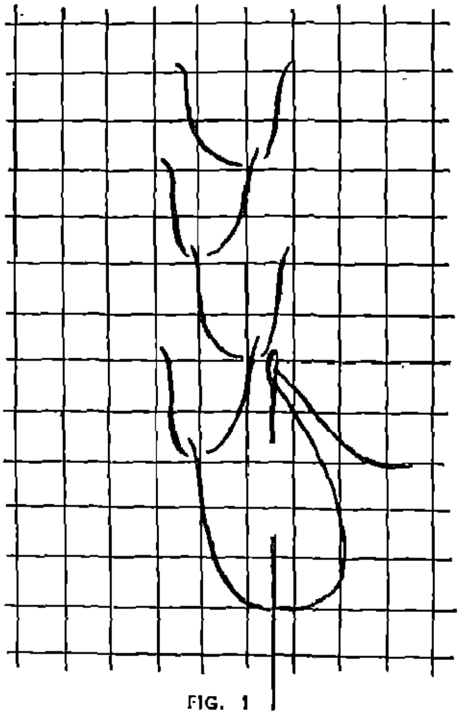


FIG. 1

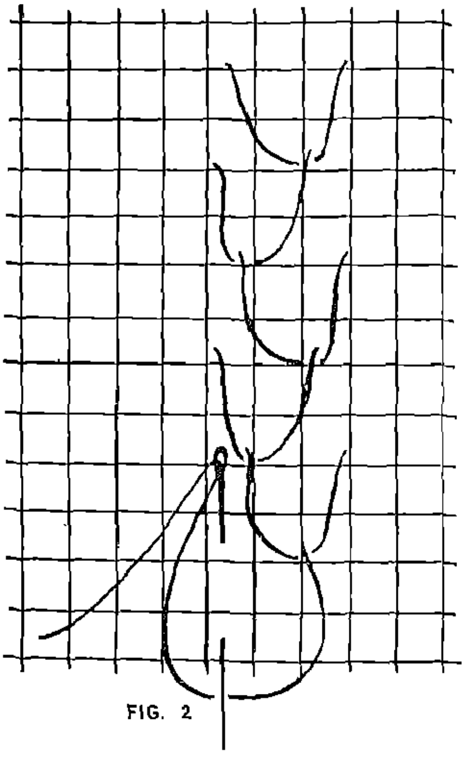


FIG. 2

the base of the last stitch formed. When finishing a thread, catch down the last stitch formed, and cut off, leaving an end. When beginning a new thread, bring the needle out through the last loop, make a small back stitch, and proceed with the stitches.

When the pupils are proficient in the working of the stitch on canvas they may proceed to practise it on their piece of crash. As an aid to gauging the length of the stitches, faint lines may first be drawn with the point of the needle on the piece of material, afterwards gauging the distances with the eye. Pupils who have proved themselves proficient in the working of simple feather stitching may practise variations for further use, Fig. 3.

Herring-boning.—Herring-boning is a large stitch which is used for holding flat a single fold of flannel, any woollen materials, or materials that do not fray easily. It consists of small running stitches worked from left to right alternately above and below the raw edges of the fold, so that one line of stitches falls on the folded portion, and the other line of stitches falls on the single material immediately beneath the fold.

1. Turn down the four edges of the piece of crash and tack in position.

2. Along one edge commence at the left-hand side by slipping the needle through the fold and passing it out about $\frac{1}{4}$ in. above the raw edge. Make a small back stitch.

3. Continue working the stitches above and below the raw edge, the needle passing out for a new stitch immediately opposite where it went in for the previous stitch, Fig. 1. The needle always points to the left and the cotton falls to the right-hand side. To keep the herring-boning a good shape, each stitch should fall opposite a space.

4. To join, insert the needle as for a new stitch in the fold and pass it through the folds of the material, bringing it out at the last stitch made on the fold. Make a back stitch here, then pass the needle for a short distance through the folds and cut off the cotton. Begin with the new cotton by completing the unfinished stitch and making a back stitch, Fig. 2.

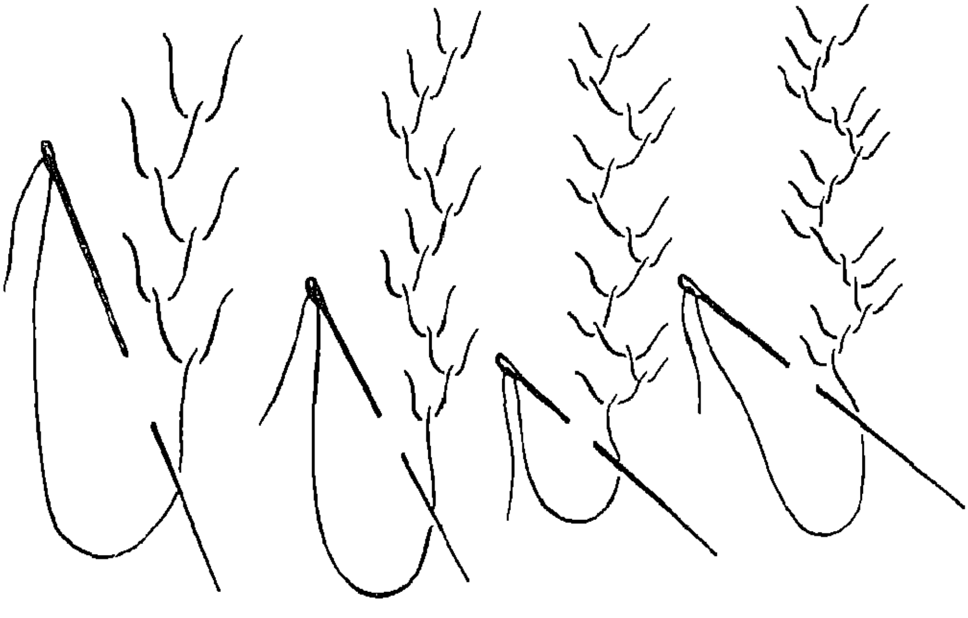
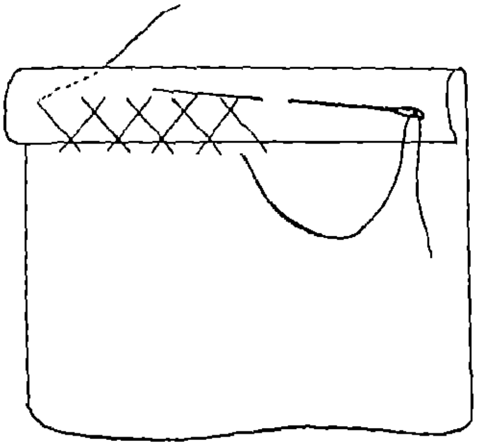


FIG. 3

5. When turning a corner, the cotton must be coming from the top row, and the stitches worked as shown in Figs. 3 and 4.

6. To end the cotton, make a back stitch on the fold, slip the needle through the fold for a short distance and cut off the cotton, Fig. 5.



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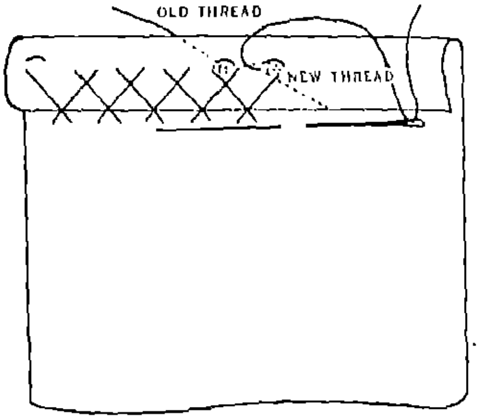

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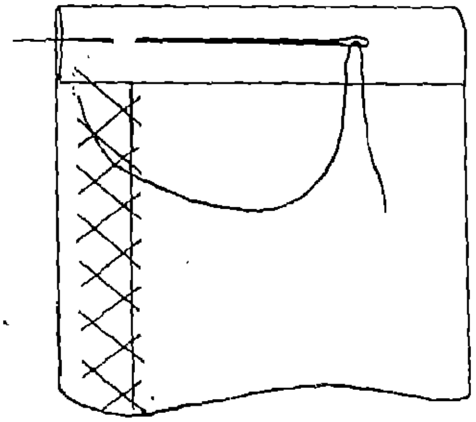

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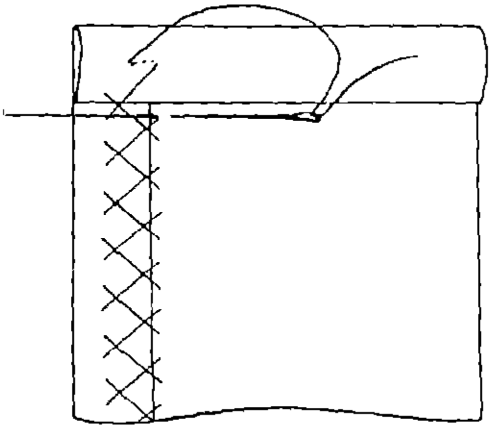

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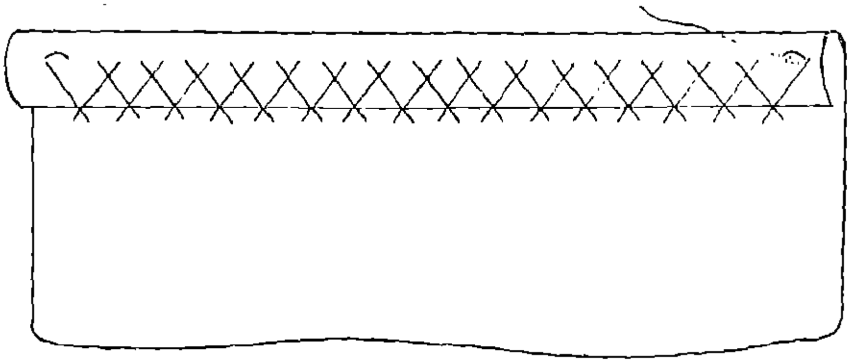


FIG. 5

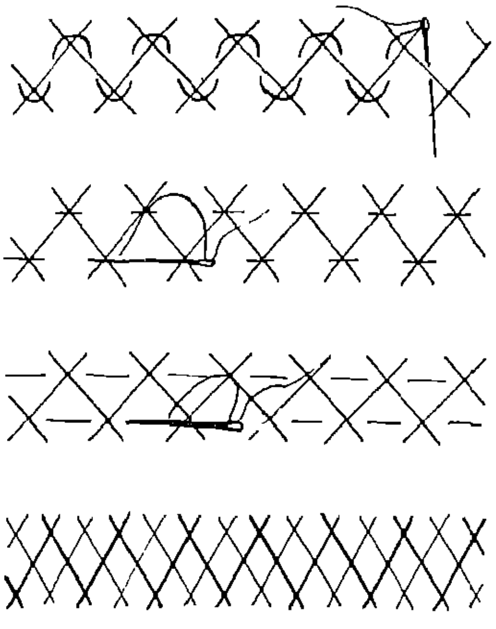


FIG. 6

Variations of herring-boning are shown in Fig. 6.

Daisy stitch.—This stitch is a variation of the simple chain stitch and is most useful as a foundation for many pretty designs.

1. Pin the crash across the easel. Place the needle in the material as for the chain stitch, Fig. 1.

2. Draw the needle through and place it through the material immediately over the loop of the stitch, passing it out at the commencement of the second stitch, Fig. 2.

Suitable designs for working the daisy stitch are shown in Fig. 3.

Stem stitch.—This stitch is known also as outline stitch or crewel stitch, and is worked from left to right.

1. Begin by making a few running stitches along the line to be covered from about 1 in. from the end. These running stitches will afterwards be covered with the stem stitches.

2. Take up a little of the material, keeping the thread to the right-hand side, and bring

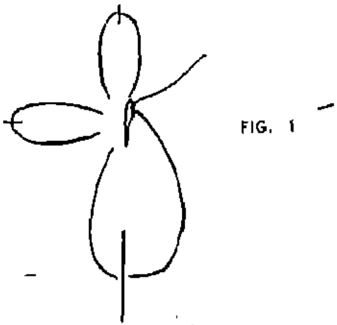


FIG. 1

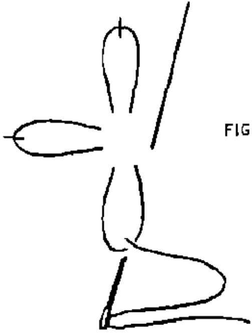


FIG. 2

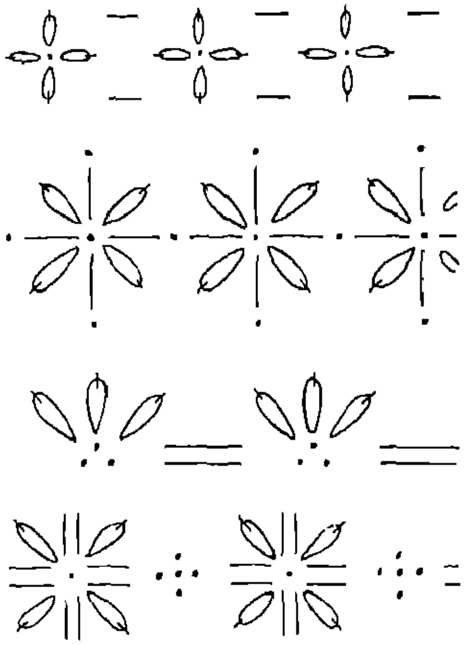


FIG. 3

out the needle a little to the right at the top of the stitch thus formed, Fig. 1.

3. This stitch may also be worked keeping the thread to the left-hand side as in Fig. 2, but whichever method is preferred the thread must be kept to the same side of the needle during the working.

Figs. 1 and 2 show the working of a broad stem line, but if a finer line is required for decorative stitchery, the needle must both enter and pass out through the material on the line to be covered, Fig. 3.

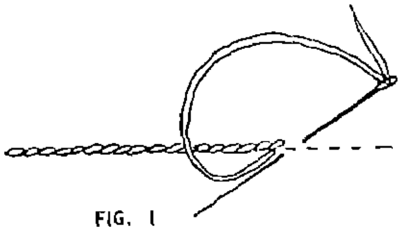


FIG. 1

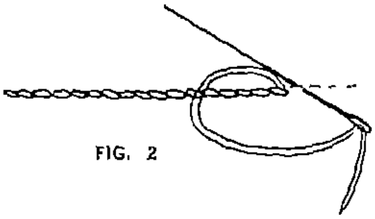


FIG. 2

4. For a stem line to be raised, first work a line of running stitches, and work the stem stitches over them.

5. To end the stem stitching, pass the needle through to the wrong side of the material, and run the cotton through several of the stitches.

Satin stitch.—Satin stitch may be worked from left to right or from right to left, or vertically from the top downwards. The stitches stretch from side to side of the space to be covered, and they may be laid obliquely or straight according to the design to be worked; e.g., if the space to be covered is wide as in a leaf, it is divided into two portions and the stitches laid obliquely as in Fig. 1. This gives the leaf a more natural appearance, and prevents the stitches having a loose untidy appearance, which would otherwise occur if they were worked straight over a wide space. Lettering, or small petals of a flower provide narrow spaces to be covered and the stitches are laid straight as in Figs. 2 and 3.

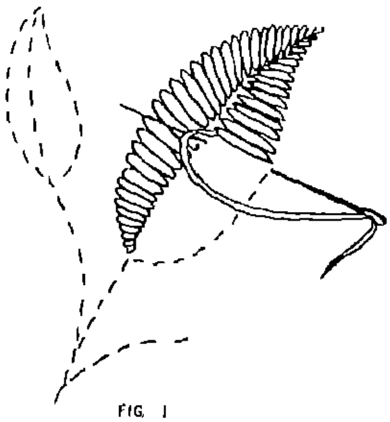


FIG. 1

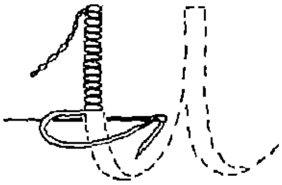


FIG. 2

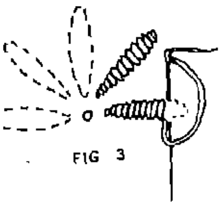


FIG. 3

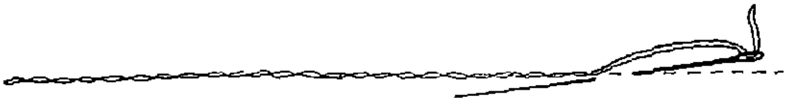


FIG. 3

1. Draw two straight lines across the crash, and then pin the crash to the easel.

2. Commence by working a few running stitches in the space to be covered, which are afterwards covered with the satin stitches.

3. Place the stitches close together to cover the fabric without overlapping, taking care to attain a neat firm line at both sides of the space, Fig. 4.

4. To obtain a raised effect, fill in the space first with rows of small running stitches, Fig. 4.

BRIEF INSTRUCTIONS FOR MAKING THE NEEDLEWORK BAG AND LINEN BAG

Needlework bag.—This bag is made from two oblong pieces of casement cloth gathered on to a cardboard circle which is afterwards lined with casement cloth.

Attach to the lining of the bag, before the two pieces of casement cloth are joined together, a pocket for holding reels of cotton, a needle and pin holder, and a thimble and scissors holder. Make all these from pieces of flannel and herring-bone them to the lining, Figs. 1 and 2.

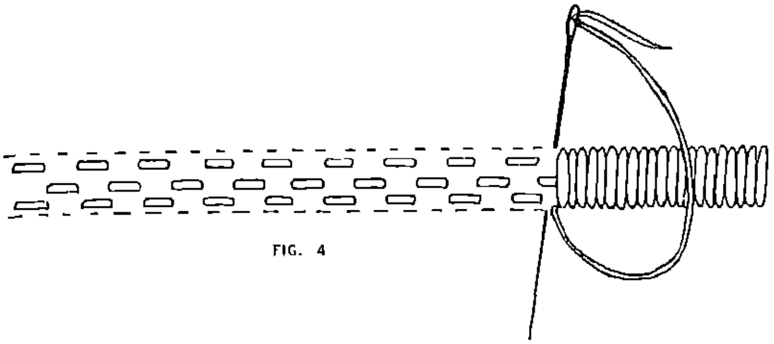


FIG. 4

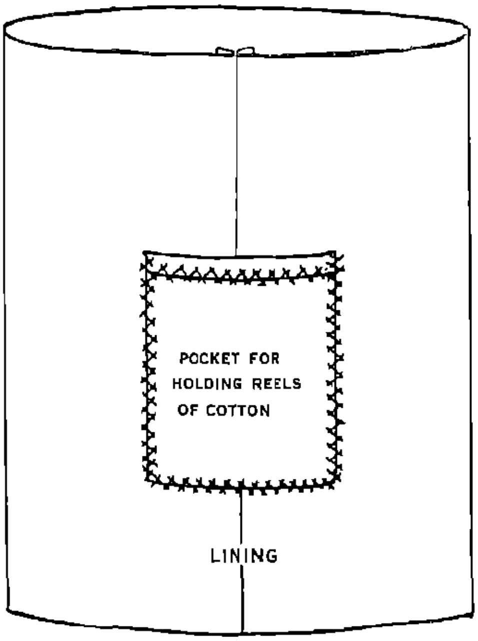


FIG. 1

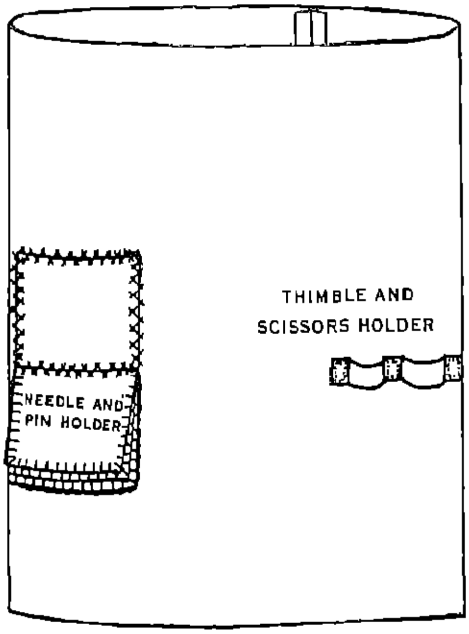


FIG. 2

On the outside piece of casement cloth work a design in daisy stitch, stem stitch and satin stitch, Fig. 3.

Join the two pieces together along the top edge, turn inside out, and form a slot by working two rows of feather stitching, Fig. 3.

Cover the cardboard circle on one side, gather the bottom edge of the bag on to it and line the inside of the circle.

Draw up with draw-strings inserted through the slot, Fig. 4.

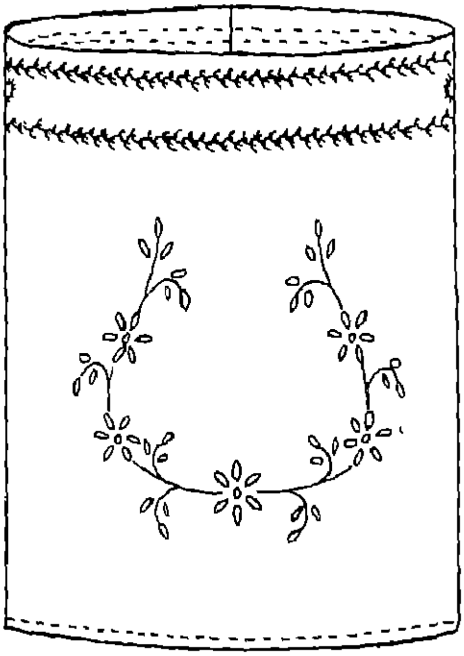


FIG. 3

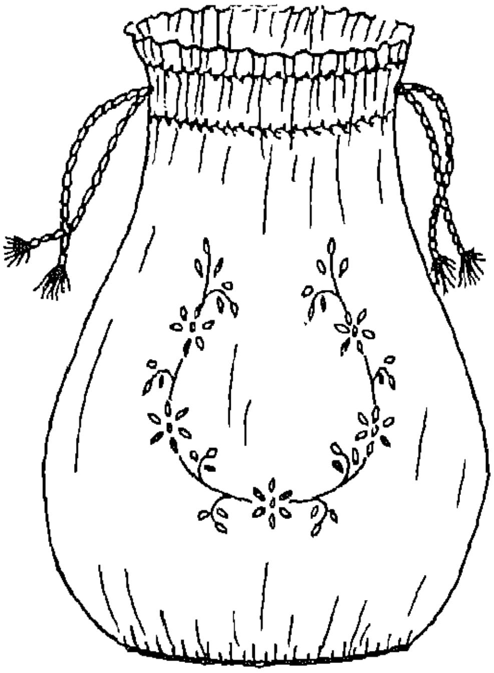


FIG. 4

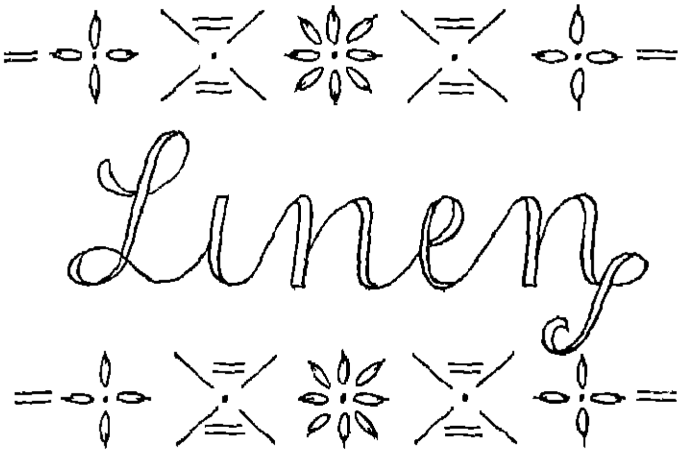


FIG. 1

Linen bag.—This bag is made from two oblong pieces of linen crash and the stitchery is worked before the bag is made up.

Write or trace the word "Linen" across the centre of one oblong piece in large copperplate lettering. Work the fine upstrokes in stem stitch and the thick down strokes in satin stitch.

Above and below the word "Linen" work a suitable design in daisy stitch, Fig. 1.

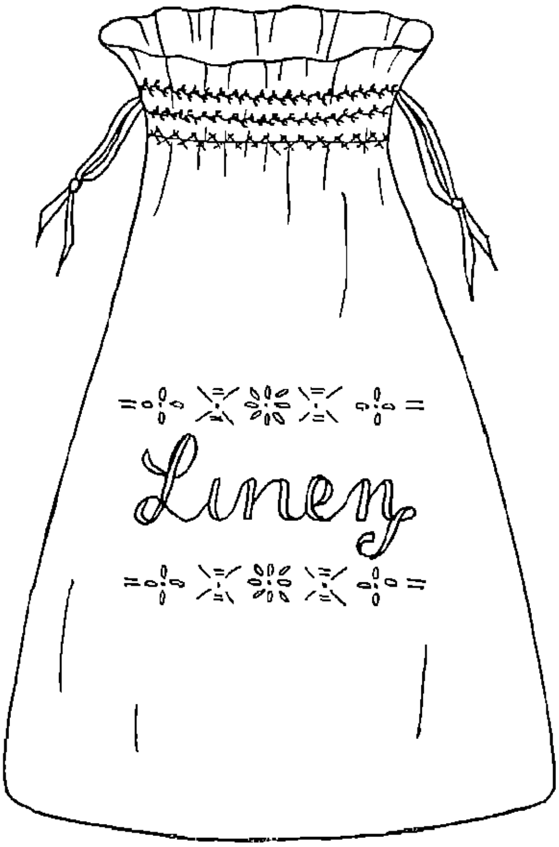


FIG. 2

Join the two pieces of the bag together along three sides, and fold a deep hem along the top edge on the right side. Hold this in position with herring-boning.

Form a slot above this with two rows of feather stitching. Insert draw-strings through the slot, Fig. 2.

VI. REPAIR WORK

Mending is one of the most important parts of the needlework scheme. Unfortunately it is a necessity, for one must mend to keep one's self-respect, and the art of mending lies in the repair work being as inconspicuous as possible. This result depends upon careful fixing, regular stitching, and the work generally presenting a neat appearance.

It is not enough for the girls only to practise the principles of patching on small pieces of new material. They must apply the knowledge gained from the class lesson to the actual garments to make them realise the value of repair work.

Aim of lesson.—To teach the pupils how to make durable repairs.

Arrangement of lesson.—While the class lesson is being given, the pupils will practise the principles on pieces of material, afterwards mounting them in their notebooks.

Teacher's requirements.—Large pieces of material suitable for demonstrating the different kinds of patches; i.e., woollen and cotton (plain and patterned); garments which have already been repaired with the various kinds of patches; charts showing the different stages in the various forms of patching; coloured wools; needles; pins; scissors; thimble; easel; drawing pins.

Children's requirements.—Pieces of material which require patching along with smaller pieces from which to cut the patches; needle; cotton; pins; scissors; thimble.

Introduction.—Patches are to give strength, therefore they must be large enough to cover the hole, the thin part around the hole, and a distance of ½ in. beyond the worn parts, so that the stitches will be worked on firm material, thus avoiding the possibility of a larger hole occurring. A patch must be of the same material as the garment to be mended, and as near to it as possible in colour, pattern and texture. New material should not be used for patching if it can be avoided. If it cannot be avoided, then it must be washed first and, if possible, be of thinner texture to correspond with the worn article.

The selvedge and weft threads of the patch should correspond with those of the garment, thus avoiding (1) undue strain which would otherwise occur through the patch being tight and the garment yielding, or *vice versa*; and (2) a patch with an ugly appearance due to bulging. A patch is usually cut square or oblong and sometimes triangular, but if the hole occurs near a seam, then the patch becomes irregular in shape through forming a line with the seam.

Patches are usually placed on the wrong side of the garment, but for outer garments they are placed on the right side, the raw edges on the wrong side being overcast and not turned in so that only one line of stitching shows. In patterned material, the patches are put on the right side of the garment in order to match the pattern and make the patches less visible.

It is advisable to fix and sew the patch before cutting away the worn part, as this keeps the garment in shape and facilitates the patching of the garment. Patches must be pressed with a hot iron when finished.

There are three common methods of patching; viz., (1) patch for woollen underclothing, commonly spoken of as a flannel patch; (2) patch for cotton underclothing, known as a calico or cotton patch; and (3) patch for outer garments, known as a dress patch.

DEMONSTRATION

A flannel patch.—

1. Cut a piece of flannel in the form of a square or oblong large enough to cover the hole, the worn part and a ½ in. space around the worn part.

2. Find the selvedge way, the right side (hairy side in flannel) and the way the nap falls. (In woollen garments the nap always falls beneath the hand from the neck to the bottom hem, as the material keeps cleaner and wears longer when made up this way than when the nap is turned upwards.) Place a pin in the centre of the patch to mark all these points.

3. Place the right side of the patch to the wrong side of the garment, the pin lying in the centre of the hole and the threads of the patch running parallel with the threads of the garment.

4. Pin the patch in position diagonally at each corner without turnings.

5. Herring-bone round the patch commencing at the bottom left-hand corner, taking care that the corners are made sufficiently strong with a square of stitches, Fig. 1.

6. Turn the garment over to the right side to cut away the worn parts.

7. Measure ¼ in. from the herring-bone stitches along each side and mark with a line of pins, marking each corner with a pin placed diagonally.

8. Cut from the hole to the pins along one side, then cut along the side parallel with the herring-boning until the next diagonally placed pin is reached. Cut round the three remaining sides in the same manner, Fig. 2.

9. Herring-bone down the raw edges to the patch, neatening the corners carefully, Fig. 3.

Figs. 4 and 5 show the completed patch as seen from the right and wrong sides.

A calico patch.—

1. Cut a piece of material large enough to cover the hole, the worn part and ½ in. beyond the worn part, having the edges straight to a thread. Find the selvedge and the right side and denote with a pin.

2. Turn a narrow fold on the right side of the material on all the edges, turning the selvedge sides first.

3. Fold the garment near the hole selvedge way and weft way and crease the fold well. This serves as a guide in placing the patch correctly.

4. Fold the patch in the same way and crease the folds well.

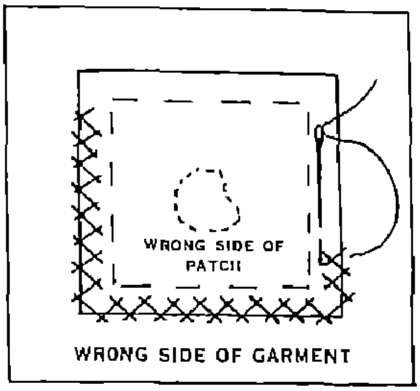
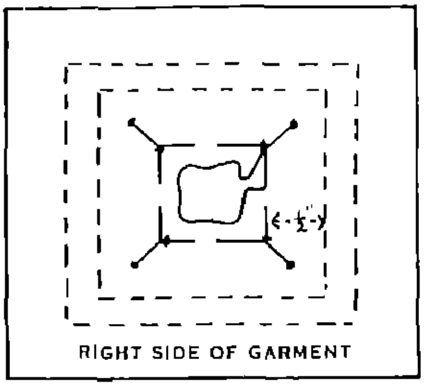


FIG. 1



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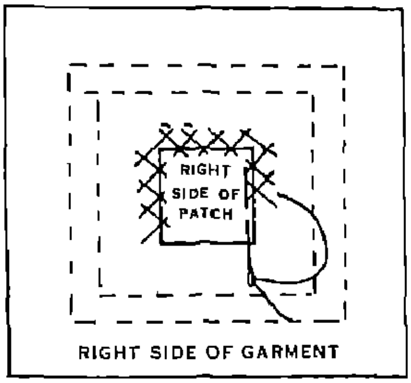

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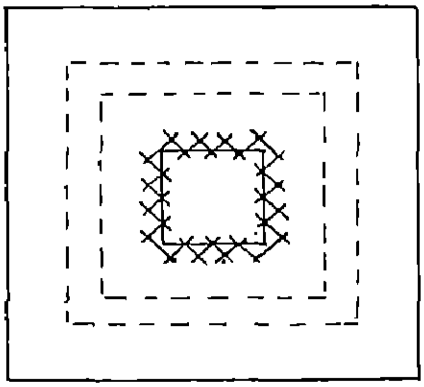
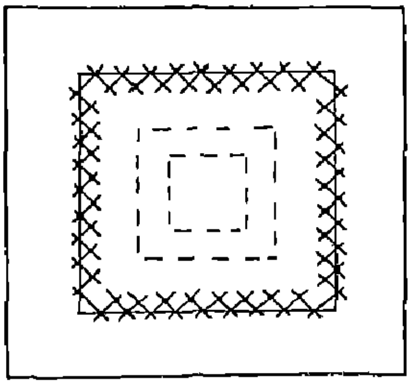




COMPLETED PATCH

RIGHT SIDE

FIG. 4

WRONG SIDE

FIG. 5

5. Lay the point where the two creases cross on the patch to the centre of the hole, having the right side of the patch to the wrong side of the garment, and the threads of the patch lying parallel to the threads of the garment. The creases of the patch should fall in line with the creases of the garment, Fig. 1.

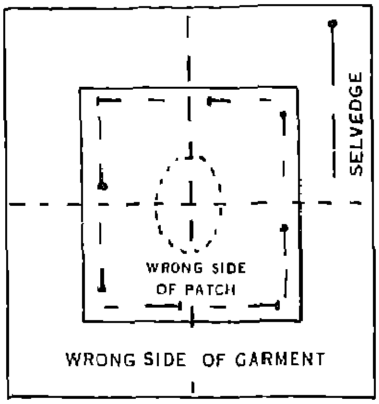


FIG. 1

6. Pin the patch in position, selvedge sides first, afterwards tacking in position.

7. Hem down the patch, beginning at a selvedge side and fixing each corner with a diagonal stitch, Fig. 2.

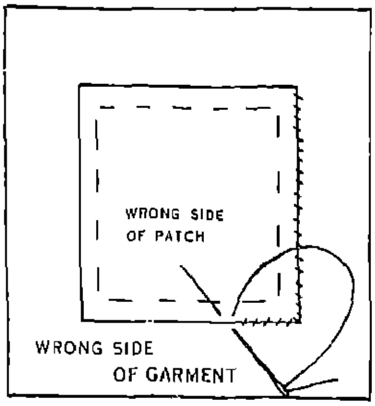


FIG. 2

8. Turn the garment to the right side to cut away the worn part. Lay a ruler across the worn part in a line at 45 degrees to the line of hemming stitches, and place a pin ¾ in. from each corner.

9. Cut from the hole along the diagonal lines to each pin.

10. Fold back each piece of material and crease the folds well. Cut off the thin parts along each crease, Fig. 3.

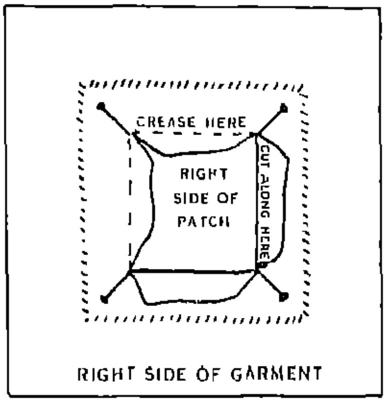


FIG. 3

11. Snip up each of the four corners $\frac{3}{16}$ in., fold in the raw edges taking care that the corners are right angles, and tack all round, Fig. 4.

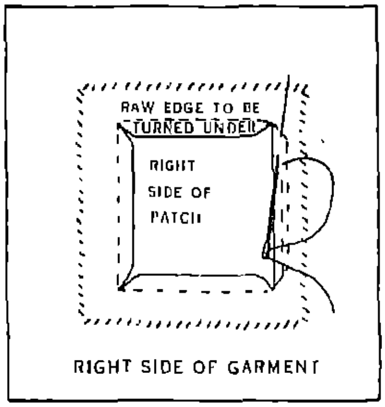


FIG. 4

12. Sew the garment and the patch together, having the patch facing the worker, placing two or three extra stitches in each

corner to strengthen them, Fig. 5. For thin materials hemming is quite strong enough when sewing the patch on the right side.

The completed patch is shown in Figs. 6 and 7 as seen from the wrong and right sides.

A dress patch.—Patterned material; e.g., print.

1. Prepare the patch, cutting the material large enough and cutting it straight to a thread. See that the pattern of the patch matches the garment. Mark with a pin the selvedge way.

2. Turn a fold on all the edges (selvedge sides first) ⅜ in. on the wrong side of the material.

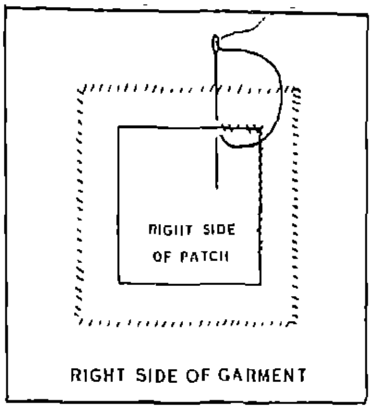
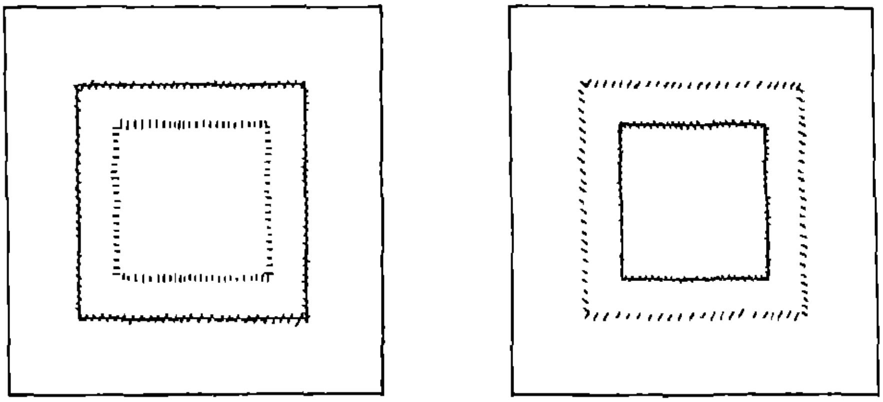


FIG. 5



COMPLETED PATCH

WRONG SIDE

FIG. 6

RIGHT SIDE

FIG 7

3. Cut away the superfluous material at each corner to give a better appearance to the patch when finished. Figs. 1, 2, 3 and 4 (p. 218) show how to cut away the superfluous material.

4. Place the patch over the hole with the wrong side to the right side of the garment, the selvedges of both running the same way and the patch lying straight to a thread. As the pattern may not be evenly printed, it is not always possible to match the pattern exactly and at the same time have the patch lying straight to a thread, but the pattern must be matched whether the threads of the patch and garment run straight to a thread or not.

5. Pin and tack the patch in position, the selvedge sides first, Fig. 5, p. 218.

6. Holding the patch towards the worker, sew the patch and garment together, strengthening the corners with extra stitches. Press the sewing flat.

7. Turn the garment to the wrong side and cut from the hole diagonally to each corner until the folded-in edges of the

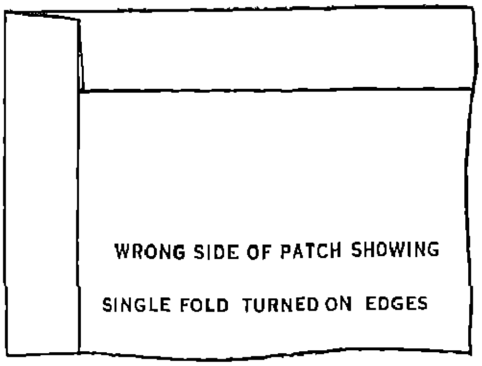


FIG. 1

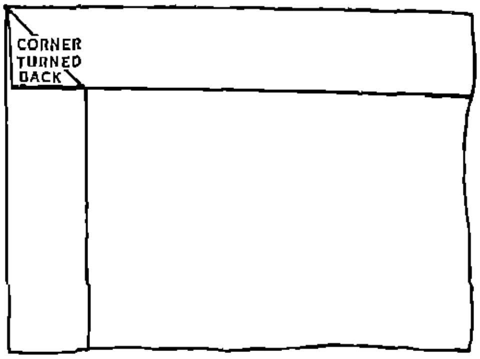


FIG. 2

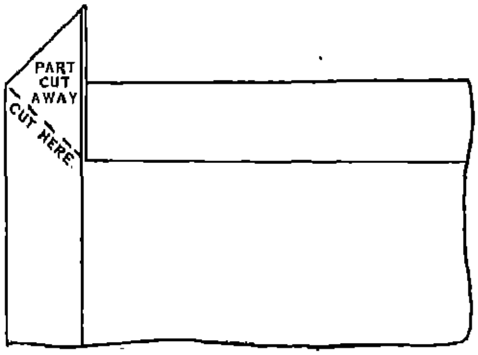


FIG. 3

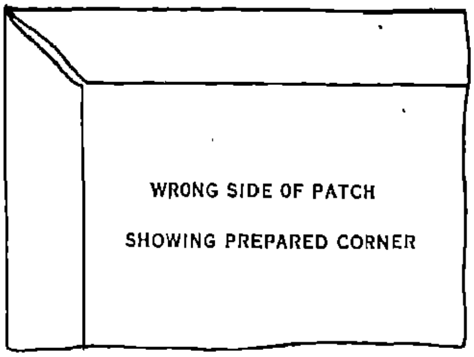


FIG. 4

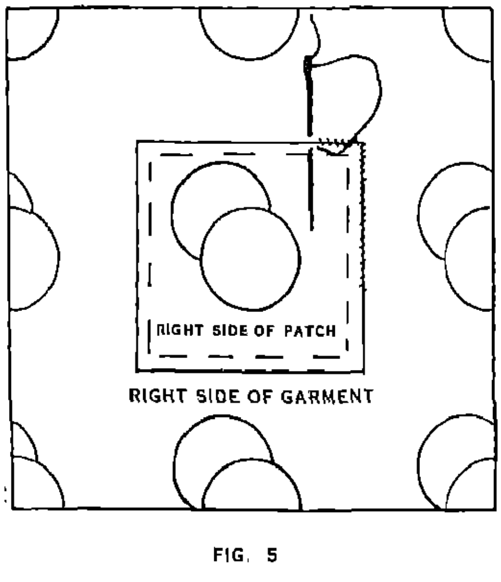


FIG. 5

patch are reached, i.e., up to ⅜ in. from the stitches.

8. Fold back the pieces of worn material, make a crease along each side parallel to the lines of stitches and cut along the creases, Fig. 6.

9. Blanket-stitch together the double raw edge left all round the hole, taking care that the stitches do not catch hold of the main part of the garment, and placing a diagonal stitch at each corner, Fig. 7.

The completed patch is shown in Figs. 8 and 9 as seen from the right and wrong sides.

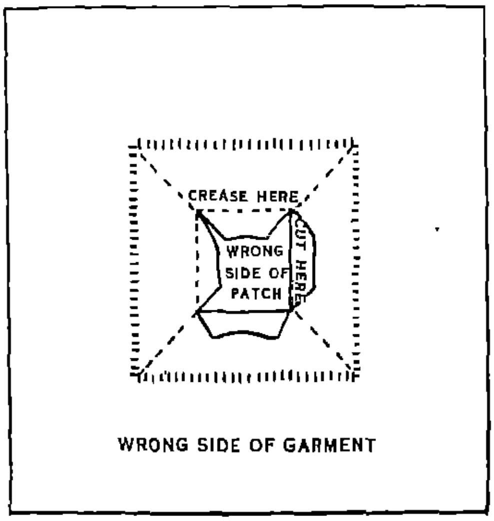


FIG 6

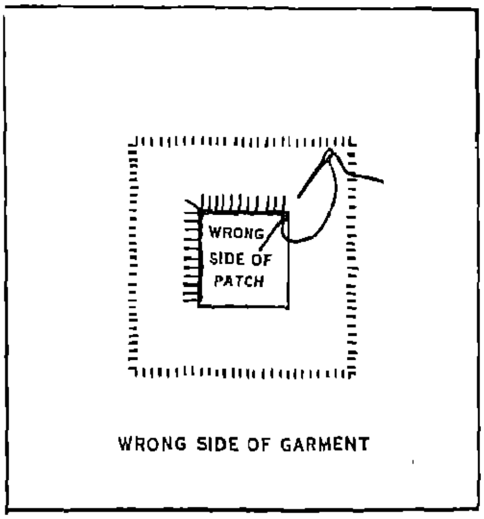
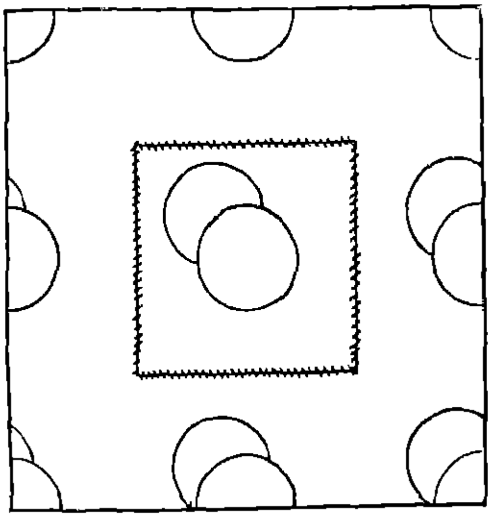


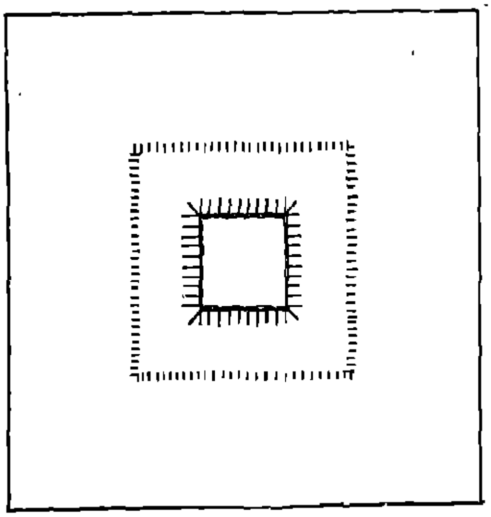
FIG. 7



RIGHT SIDE

FIG. 8

COMPLETED PATCH



WRONG SIDE

FIG. 9

VII. DARNING

In the teaching of needlecraft, darning—as a section of repairing—holds an important place. It is usually worked on single material in the strengthening of a weak part, or the mending of a torn or worn portion. The aim of darning is to repair weak parts in such a way that the repaired section is hardly discernible. To attain this result, darning threads are used of a similar colour and texture as the threads of which the material is composed.

The darning stitch taught in the junior school is now revised, and a preparatory stage to darning in stocking web is made by introducing the darning stitch on single thread canvas. This enables the pupils to accustom themselves to picking up one thread and passing over another before commencing with the stocking web, instead of lifting a piece of material as formerly.

Arrangement of lesson.—The pupils work along with the teacher as she demonstrates each step.

Teacher's requirements.—A darning frame; large needle; coloured wools; scissors; knitted garments which have been repaired by the different methods; knitted garments containing a thin place and a hole which need repairing; a chart showing illustrations of the various stages in the process of darning; a large piece of knitting which has been worked loosely on large wooden needles for demonstration purposes.

Children's requirements.—7 in. squares of single thread canvas; coloured wools; long fine darning needles; pieces of knitted web; knitted garments containing a thin place and a hole which need repairing; wools similar in colour and texture to the knitted garments.

DEMONSTRATION

Working the darn.—

1. To thread the needle place one end of the wool over the needle and hold both pieces of wool close to the needle. Draw the needle out of the loop and pinch the loop firmly. Place the loop of the wool to the eye of the needle and draw it through with the thumb and first finger of the left hand.

2. Darning is worked parallel to the selvedge threads and consists of "up rows" and "down rows."

3. Begin at the bottom left-hand corner of the square, about $\frac{1}{2}$ in. from the lower and side edges. Insert the needle between two selvedge threads and work upwards, picking up one thread, passing over the next, and so on until there are about ten threads on the needle. Draw the needle through, leaving the wool passing between threads, Fig. 1.

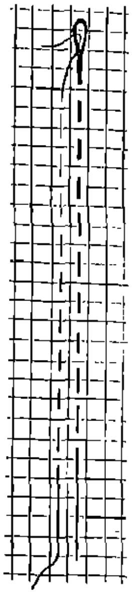


FIG. 1

4. The next row is the "down row." Take the needle towards the right, inserting it one thread up above the last stitch of the first row, so that the wool now passes over the threads that it went under in the first row, Fig. 1. Take up the same number of threads in each row.

5. When drawing the wool through the threads, leave a small loop about $\frac{1}{8}$ in. long at the end of each row. This is to allow for the shrinkage of the woven cloth materials, and to preserve the elasticity of knitted material, Fig. 1.

6. Continue working similar rows to the first and second, observing the rules each time, until eight or nine rows of darning have been worked, Fig. 2.

7. By this time sufficient darning will have been done for the pupils to build up another rule for themselves; viz., that in darning, a straight edge must always be avoided. Pull the canvas to show that the whole weight of the darn rests on the thread at the top and the thread at the bottom of the darn, and that this would

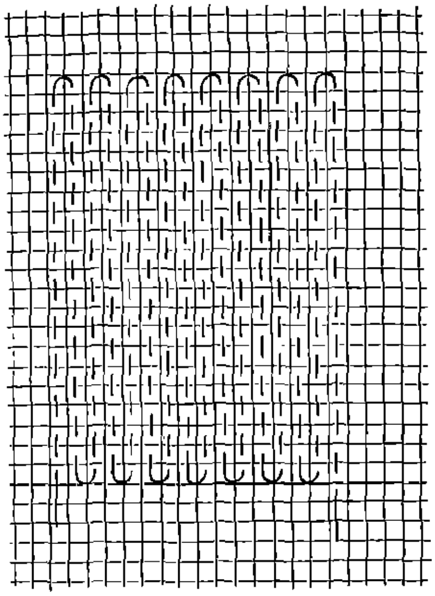


FIG. 2. WRONG SHAPE OF DARN STRAIN ON TOP AND BOTTOM THREADS

result in the piece darned being torn away from the garment, thus causing more holes.

8. Suitable shapes for darns, which avoid this straight edge, are shown in Figs. 3, 4 and 5, Fig. 3 being the method usually adopted.

9. To work the darn shown in Fig. 3, commence at the left-hand side as before, but pick up three threads only. Work towards the right, inserting the needle one thread up above the last stitch, and pick up four threads, increasing one at the bottom of the "down row."

10. Continue increasing each row until five "up rows" and five "down rows" have been worked, then work level for the next four "up" and three "down" rows, afterwards decreasing a stitch each row until three threads only are picked up. Cut the wool.

11. Work a specimen of each of the darns shown in Figs. 4 and 5, increasing and decreasing as in Fig. 3. When the process has been mastered and the correct shapes obtained, darning on stocking web may be commenced.

Darning in knitted web.—In knitted web the *knitting* takes the place of the canvas threads, so that now one stitch of the *knitting* is picked up and one stitch passed over by the darning threads. The loops on the right side of the knitted web are arranged in a series of upright columns. On the wrong side the loops of one column are curved upwards away from the worker, while those on the column at each side of it curve downwards towards the worker. Across the web the loops lie in ridgelike rows. Darning is usually done on the wrong side of the web, with the upward and downward loops running from top to bottom, and the ridgelike rows running from left to right.

All these points must be carefully observed if a successful darn in knitted web is to be achieved.

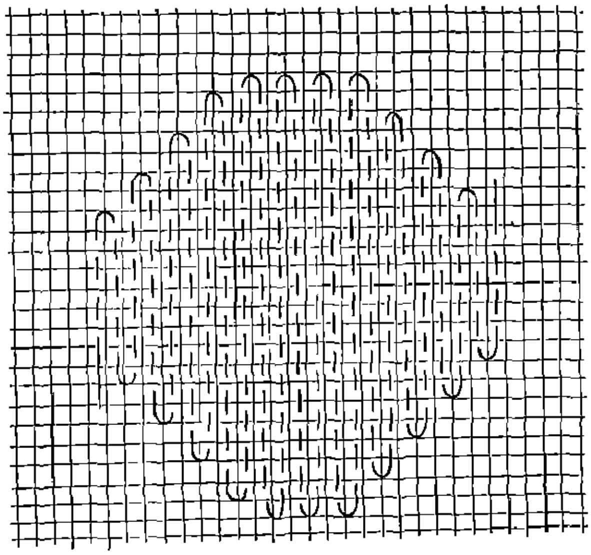


FIG. 3

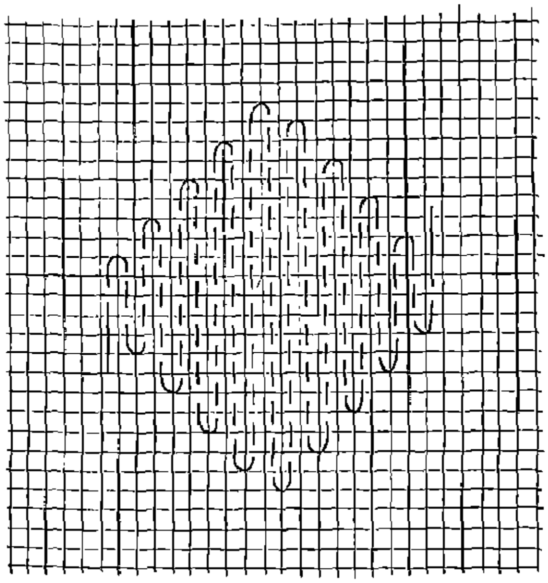


Fig. 4

Darning a thin place in knitted garments.—

1. Imagine a thin place in the web and commence at the left-hand side as before, inserting the needle under one of the upward curved loops and passing over the next curved loop until three loops are taken up, Fig. 6.

When drawing the needle and wool out, place the left thumb on the web to prevent the darn from puckering, thus avoiding strain.

2. In the next row, insert the needle in the downward curved loops, and continue working the darn as for the second method on the canvas; i.e., as in Fig. 3, taking care that the strands are not left too loose, or drawn too tight Fig. 7.

3. If the thin place is very weak the darn may be "crossed" as in darning a hole.

Darning a hole in knitted web.—The darning wool must be similar in colour and texture to the garment being repaired. The thin part round the hole must always be included in the darn.

1. Work the darn as for a thin place until the hole is reached. When crossing the hole, each darning thread must take up one free loop of the web at the edge of the hole to prevent the hole from running further, and in order that the darn may be as smooth and flat as possible, Fig. 8.

2. Continue across the hole, afterwards decreasing beyond the hole at the right side, Fig. 8.

3. Begin beyond the hole when crossing the darn, passing the needle under and over the darning threads instead of through the web, at the same time taking care that the first strands over the hole are not split by the needle. To avoid any chance of splitting,

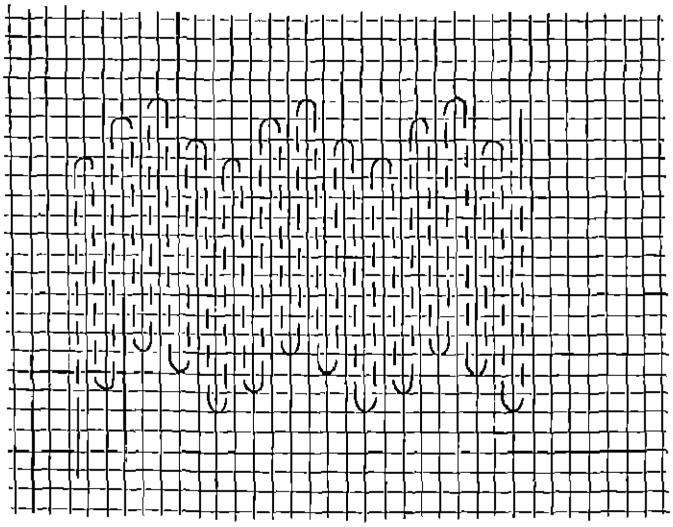


Fig. 5

crossing the darn may be done by inserting the eye of the needle first instead of the point, Fig. 9.

4. Work these threads closely so that the darn when completed resembles the stocking web in tension, Fig. 10.

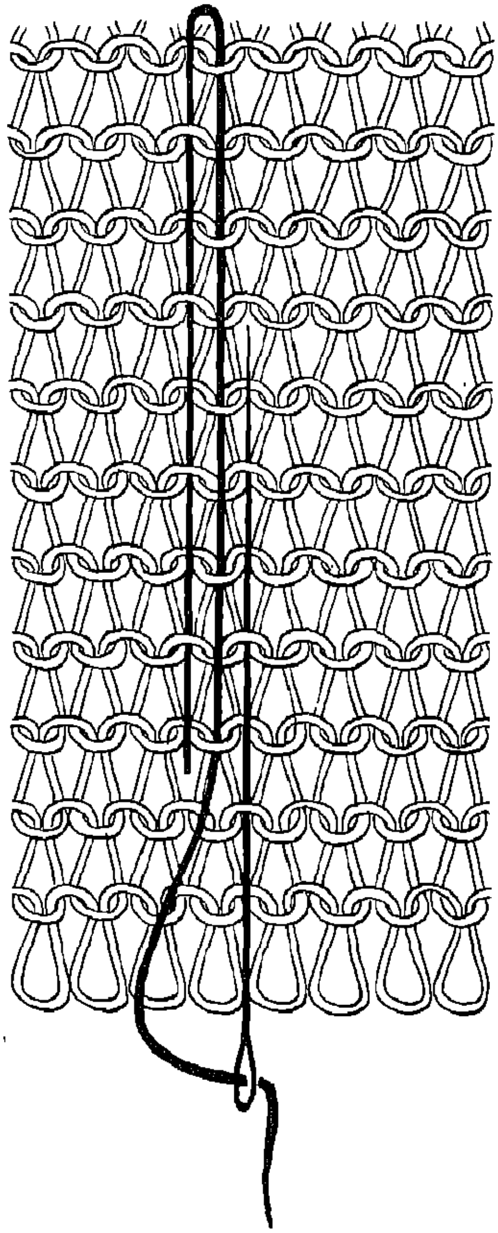


FIG. 6
BEGINNING OF DARN IN KNITTED WEB

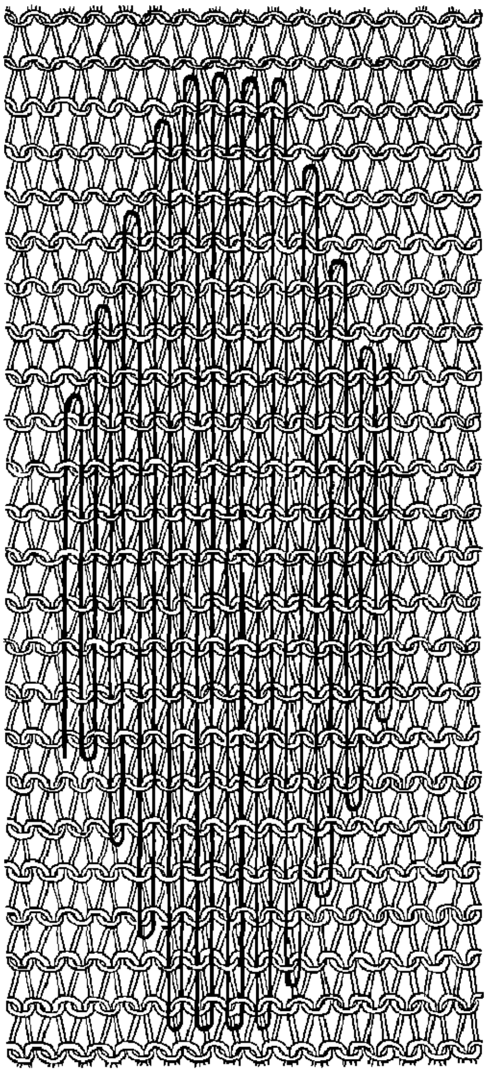


FIG. 7

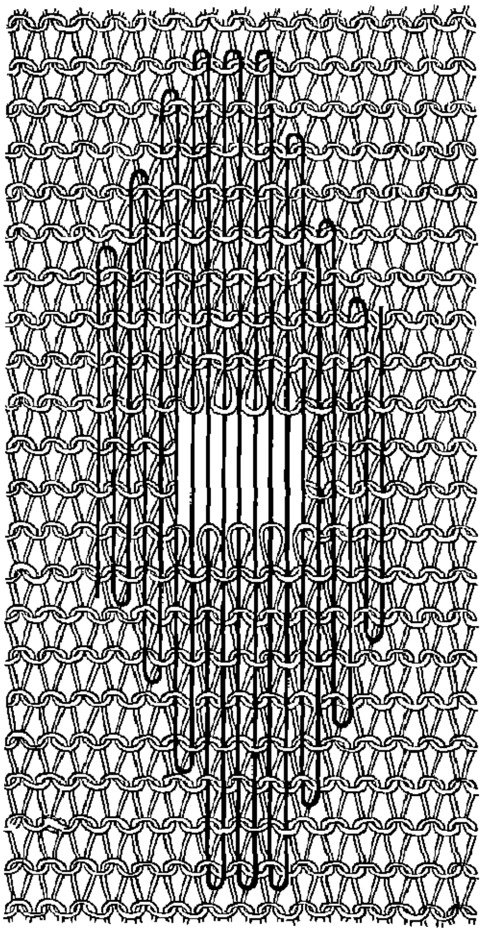


Fig. 8

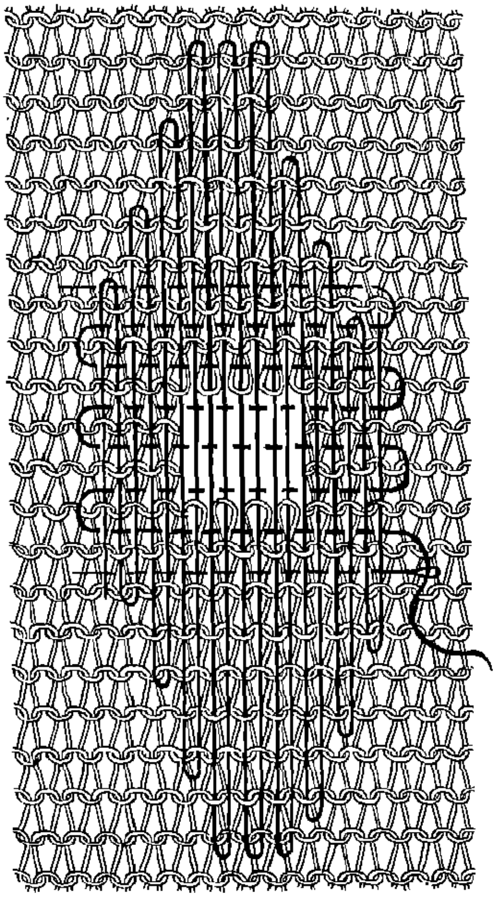


Fig. 9

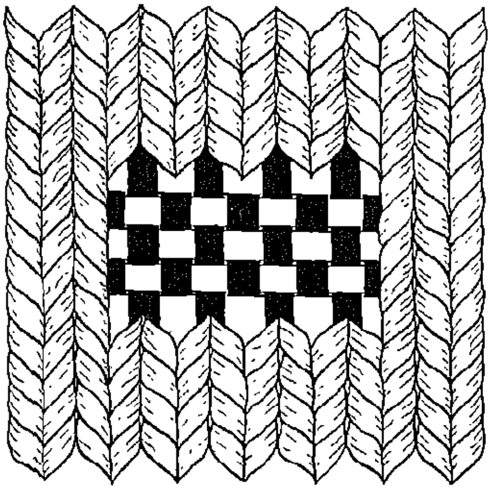


Fig. 10

FIRST YEAR COURSE—SECOND TERM

Pattern making.—Bodice.

Garment or article to be made.—Petticoat; needlework bag or linen bag continued.

Knitting.—Scarf.

Processes.—Machining; scalloping.

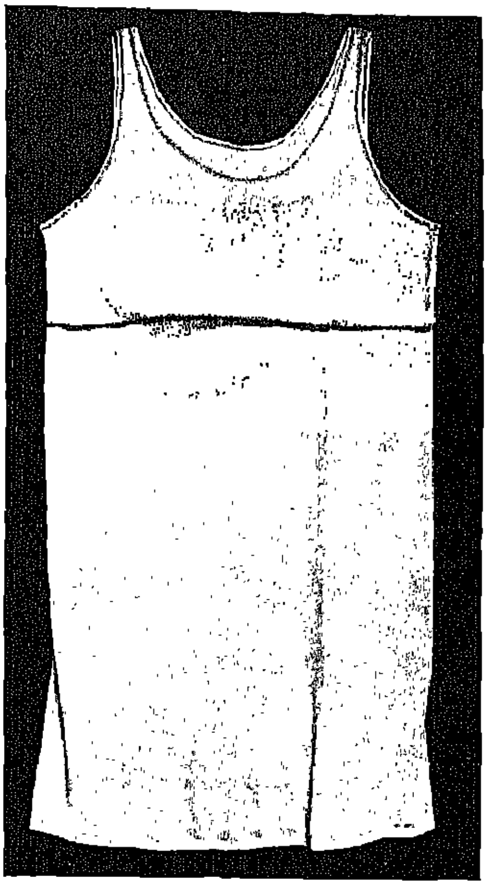
Decorative stitchery.—Cross stitching; fishbone stitch; Pekinese stitch; stitched chain stitch; further application of the stitches learnt in the first term.

Repair work.—Variation of the woollen patch; cloth patches.

Discussion of work.—The stage is now reached where an advance must be made on the loose-fitting type of garment; i.e., the construction of a bodice pattern which follows the lines of the figure. A pattern should be exhibited and its chief features briefly noted.

During the discussion three different types of petticoat should be shown; one with the neck and armholes faced with a crossway strip and embroidered; another with the neck and armhole edges scalloped; and a third having an "opera top" edged with lace and a slash at the hips with gathers or pleats inset. Attention must be drawn to the machined seams and the various stitches and processes involved in the making up of these garments.

The completed decorative article for the year's work should again be in evidence, and any likely difficulty commented upon. At the same time it would be encouraging to the pupils if the teacher were to show a pair of guest towels, one having the edge scalloped and the other having the end worked in a cross-stitched design. This would tend to make the pupils eager to work similar ones at home.

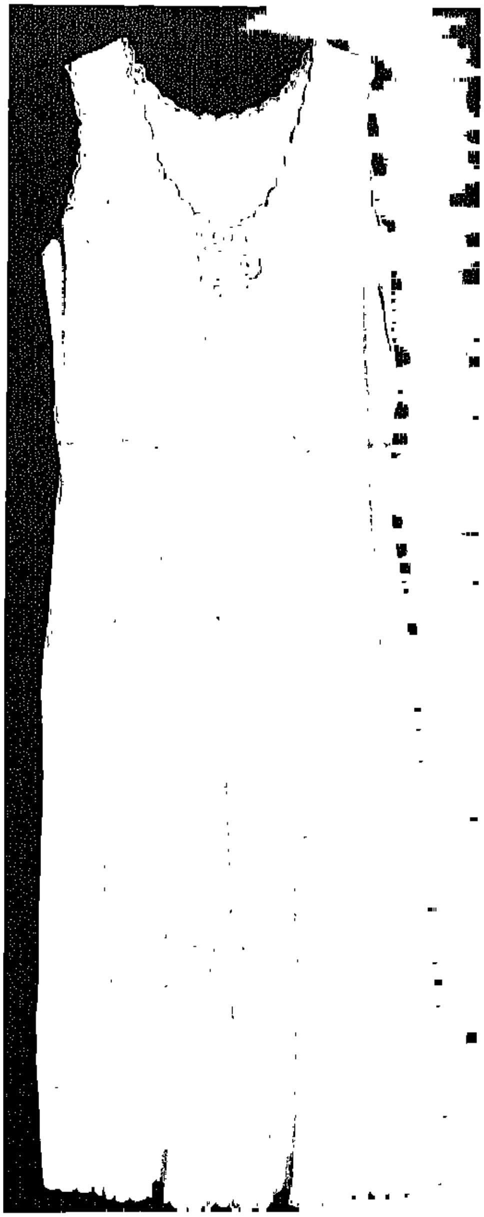


PETTICOAT SHOWING THE EDGES FACED AND EMBROIDERED

Reference must be made to the knitted set, the scarf being the article in question for the second term.

For the repair work, woollen or cloth skirts or dresses which have been repaired should be exhibited to show more difficult forms of patching which will be taught during the term.

After the discussion of the work the bodice pattern may be considered preparatory to the drafting of the pattern in the next lesson. Growing girls vary considerably, and the points which were unnoticeable previously now become obvious; e.g., the slope of the shoulder; the difference between the lines of the front and the lines of the back, especially at the neck and the armholes, etc. To impress these differences and to convey them clearly to the mind, the pupils should be provided with a bodice pattern and allowed to trace along the newly discovered lines with the finger before beginning to draft the pattern on paper. Attention must also be drawn to the relative



Petticoat Showing the Neck, Armholes and Bottom Edge Scalloped

Petticoat Showing "Opera Top" Trimmed with Lace and Embroidery, and Having a Slash at the Waist positions of the drafting lines and the proportions of the various measurements which are as follows:—

1. The bust line lies half-way between the neck and the waist.

2. The chest line and the widest part of the back lies half-way between the neck and the bust.

3. The width of the back is approximately one-third of the bust measurement.

4. The width of the back neck is one-third the width of the back.

I. DRAFTING THE BODICE PATTERN

Arrangement of lesson. — The teacher demonstrates the drafting of the pattern on a large piece of paper pinned to the backboard, the pupils working with her, step by step.

Teacher's requirements.—A large sheet of drafting paper; coloured pencils; two blackboards—on one the draft of the bodice pattern is illustrated, different coloured chalk lines denoting the creases in the paper and the pattern itself, on the other blackboard the sheet of drafting paper must be pinned; a drafted pattern; glass-headed pins; a 3 ft. ruler; a finished garment; tape measure; scissors.

Children's requirements.—A sheet of drafting paper; pencil; ruler; tape measure; scissors; notebook.

DEMONSTRATION

Measurements required.—Two measurements are required—the length of the back and the bust measurement.

Length of back.—Tie a piece of tape firmly round the waist and measure from the bone at the nape of the neck down the centre back to the waist.

Bust measurement.—This is taken with the tape measure placed round the fullest part of the figure above the waist, the tape being raised with two fingers placed under the tape at the centre back for about 2 in. above the horizontal line to give an easy fitting measurement, Fig. 1.

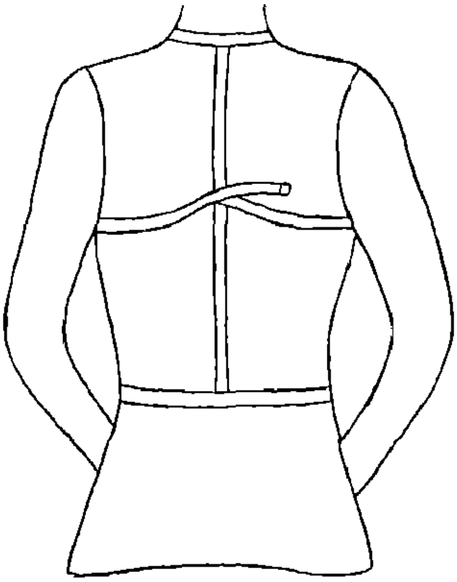


FIG. 1

The girls must measure each other, the teacher afterwards confirming the measurements.

Drafting the pattern.—

1. Draw an oblong, ABCD.

AB = half bust measurement plus 1 in.

BC = length of back.

Draw a line A^1B^1 $\frac{1}{2}$ in. above AB and continue DA and CB to meet it. Cut out the oblong A^1B^1CD, Fig. 2.

2. Fold the oblong ABCD lengthways into four equal parts and widthways into three equal parts. Crease well and open out the paper. Draw in the pattern as follows:—

Back of pattern.—

EF denotes the width of the back.

$A^1G = \frac{1}{3}$ EF (back neck line). Join AG with a curved line.

$FH = A^1G$.

$HH^1 = \frac{1}{2}$ in. for the armhole curve. Join GH^1 for the shoulder line.

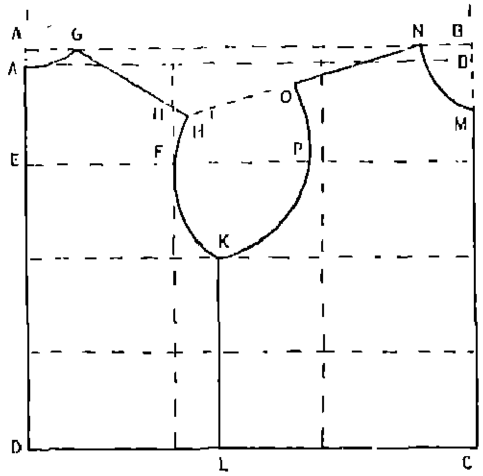


FIG. 2

K = $\frac{1}{3}$ division. Join H^1K with a curved line passing through F.

KL is a perpendicular line from K.

Front pattern.—

$BM = B^1N = A^1G$ plus ½ in. Join NM with a curved line.

Join NH^1 to obtain the slope of the shoulder.

$NO = GH^1$.

P = ½ in. in from the division. Join OK with a curved line passing through P.

Cut out on the pattern lines.

The pupils must make brief notes on the draft of the pattern in their notebooks at the first opportunity.

II. DRAFTING THE PETTICOAT PATTERN

(Adapted from the Bodice Pattern)

Aim of lesson.—To instruct the pupils how to adapt a block pattern to meet other requirements.

Arrangement of lesson.—As the teacher drafts her pattern the girls will follow her, step by step, drafting their own pattern.

Teacher's requirements.—Three different kinds of petticoat; pattern of bodice; sheet of drafting paper; coloured pencils; scissors; drawing pins; ruler; tape measure; blackboard showing the draft of the petticoat pattern, the bodice and petticoat patterns being traced in different coloured chalks; a completed pattern.

Children's requirements.—Pattern of bodice; a sheet of drafting paper; pencil; tape measure; ruler; pins; notebook.

DEMONSTRATION

Measurements required.—1. Length from shoulder to knee; 2. Width at the bottom—usually from 48 in. to 54 in.

The girls must measure each other, the measurements being confirmed by the teacher before being used.

Drafting the pattern.—Pin the sheet of drafting paper on the blackboard and place the centre of the back pattern of the bodice to the edge on the right. Make the following alterations, Fig. 1:—

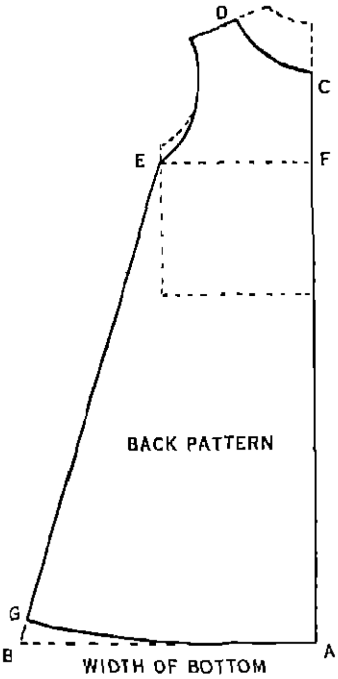


FIG. 1

1. Continue the centre back line to the length required, A.
2. Measure ¼ width required along the bottom from A to B.
3. Lower the neck 2 in. or 3 in. as desired, C.
4. Measure 2 in. along the shoulder line from the neck curve, D.
5. Lower the armhole 1 in. for easy fitting, E.
6. EG = FA (to avoid a dip at the sides).
Cut out on the altered pattern lines.
7. Place the centre of the front pattern of the bodice to the edge of a new sheet of drafting paper and make the same alterations as for the back pattern except that the neck line is lowered to 3 in. or 4 in. as desired, Fig. 2. Cut out.

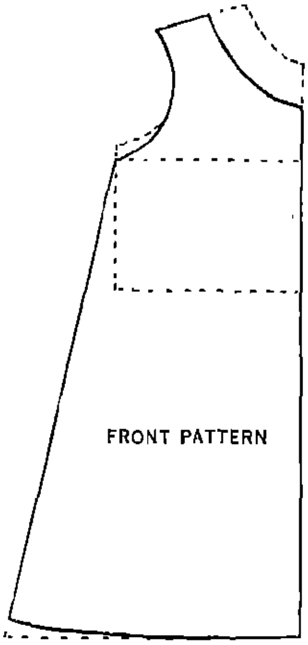


FIG. 2

8. Fig. 3 shows the bodice pattern adapted to form the pattern of a petticoat with a slash at the hips:—

(*a*) Continue the under-arm line of the bodice for 3 in. or 4 in. below the waist, A.

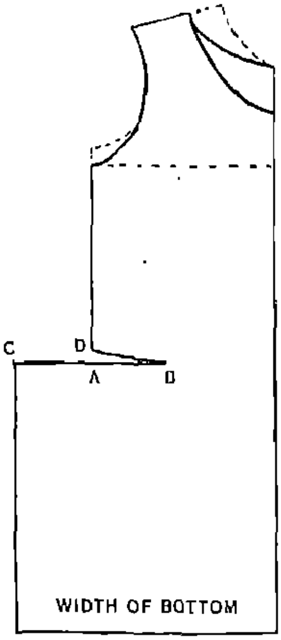


FIG. 3

(*b*) Cut towards the centre front and back from A to B = 3½ in. This must be done on the waistline if the slash is required at the waist instead of the hips.

(*c*) Continue BA to the perpendicular line which is drawn from the point denoting the width at the bottom, C.

(*d*) Measure ¾ in. along the under-arm line from A to D and curve to B to avoid a dip at the sides.

Fig. 4 shows the bodice of the petticoat pattern turned down to form the pattern of a "party" petticoat with an "opera top."

III. MACHINING

The pupils should by now have reached the stage where machining may be introduced and taught successfully with a little patience and perseverance. A sewing machine is a useful and necessary part of the equipment of a needlework classroom, as by its aid

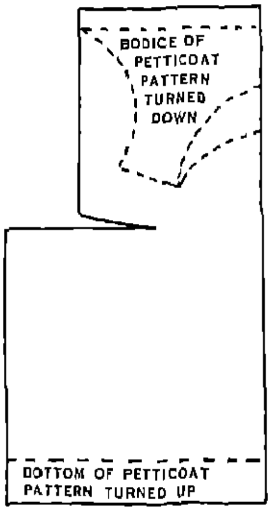

BODICE OF PETTICOAT PATTERN TURNED DOWN
BOTTOM OF PETTICOAT PATTERN TURNED UP

FIG. 4

much time and labour are saved in the making of garments. As the machine is only an auxiliary in this work, the success of the garment depends upon the work of the machinist and the extent of her knowledge as regards the mechanism of the machine, the adjustment of its various parts, and the careful handling of the machine. Proficiency in machining can be acquired only by much practice in actual stitching with the machine itself, and such articles as dusters, glass-cloths, etc., provide good practice for straight running before attempting the machining of a garment which involves curves. Where possible the girls should be encouraged to practise machining at home.

Aim of lesson.—To teach the pupils the art of machining carefully and evenly.

Arrangement of lesson.—The teacher must first demonstrate the general manipulation of the machine, afterwards working on a strip of material rows of machining to illustrate correct and incorrect tensions. As many sewing machines as the teacher can command must be placed at the disposal of the pupils. The class may be divided into groups with a capable and competent girl in charge of each group who will supervise the working of the machine to prevent any accidents. The pupils will then practise machining on their own strips of material.

Teacher's requirements. — A sewing machine; blackboard containing notes on machining for the pupils to copy in their notebooks; diagrams of the threading of the needle and the shuttle; diagrams showing the correct and incorrect tensions; strips of material to pass round the class showing rows of machining, one with correct tension, one with loose upper tension, and one with loose shuttle tension (the strips of material must be of different colours and machined with two colours of cotton so that the upper and lower tensions are easily distinguished); needle; scissors; thimble; a machined article.

Children's requirements. — A sewing machine; scissors; needle; thimble; strips of material on which to practise machining; notebook in which to place the best specimen of machining.

DEMONSTRATION

1. General manipulation of the machine.—The teacher must demonstrate the following points:—

(*a*) How to thread the needle.

(*b*) The correct way of winding the shuttle and placing it in the case.

(*c*) Altering the size of the stitch.

(*d*) Regulating the tension. Examine the strips of material to note the tension. In good machining the stitch should lock just between the two layers of material, Fig. 1,

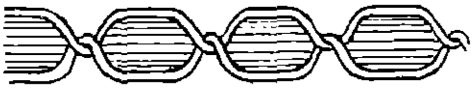


FIG. 1

and not allow one thread to lie straight along the upper or lower surfaces of the material, Figs. 2 and 3.

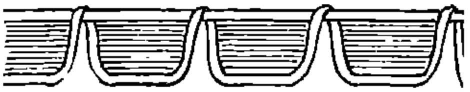


FIG. 2

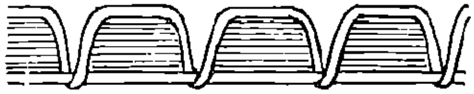


FIG. 3

2. Position at the machine.—

(*a*) The chair or stool must be of a suitable height for each pupil.

(*b*) The pupil should sit squarely on the chair.

(*c*) The correct position of the feet for treadling must be shown if a treadle machine is used.

3. Control of the machine.—It is not advisable for the pupils to start and stop the machine themselves at first, but to give their full attention to keeping the stitches in a straight line. When this is accomplished, then controlling the machine may be practised, the teacher demonstrating this process first. The pupils will experience difficulty at first with the wheel "running back," but after continued practice they will readily be able to start and stop at will, and learn to make a good stitch with a steady running of the machine.

4. Machining.—

(*a*) Always tack the part of the garment to be machined before machining.

(*b*) Place the material carefully under the "foot" to avoid complications with the cotton when beginning.

(*c*) Do not watch the needle when sewing, but use the "foot" as a guide to keep the machining in a straight line.

(*d*) Place the main portion of the material to be sewn to the left, so that as little as possible lies between the wheel and the needle.

(*e*) When beginning or ending, draw the ends of the cotton through to the wrong side, thread through a needle, make a back stitch, and slip through the fold of the material for a short distance; then cut off.

(*f*) Machine evenly and close to the hem.

(*g*) The pupils should read thoroughly the book of instructions given with each machine to enable them to become conversant with the general rules for machining different fabrics.

5. Care of the sewing machine.—All students learning to use a sewing machine should be impressed with the necessity for keeping the machine in good working order. After use, remove with a soft duster all loose fluff and dust which has collected on the needle plate, and replace the cover. It is essential to good and easy working that the machine is cleaned regularly and oiled often. The principal parts must be taken to pieces and cleaned well with paraffin oil, afterwards removing all traces of dirt and oil with an old cloth. Oil with a good oil only, as inferior oil tends to clog the machine sooner than dirt. After oiling, work the machine gently for a few minutes so that the oil is well distributed. Before using the machine again, first sew a few inches on a piece of waste material to make sure that there is no oil left to soil the work to be done.

IV. THE MACHINING OF GATHERS

Aim of lesson.—To show how to machine a gathered portion to a fitted portion.

Arrangement of lesson.—The pupils will work along with the teacher step by step.

Teacher's requirements.—A garment showing a gathered portion machined into a band (as in a blouse cuff); a petticoat with a slash at the hips, showing the gathered portion machined into a fitted portion; a prepared band and coloured strip of material gathered to fit it; three straight strips of material, and three coloured strips of material gathered to fit each straight strip respectively; two crossway strips of material; needle; thimble; pins; coloured wool; scissors; sketches illustrating the various stages of the lesson drawn on the blackboard or on a chart; an easel. (Prepare the band by machining the short ends at each side to within ½ in. of the raw edges along the bottom.)

Children's requirements.—A prepared band 4 in. long and a strip of material gathered to fit it; three straight strips of material 4 in. long, and three strips gathered to fit them; two crossway strips of material ⅝ in. wide and 4 in. long; pins; cotton; needle; thimble; scissors; notebook.

DEMONSTRATION

1. Machining gathers into a band.—

(*a*) Tack along the fold to keep the band straight.

(*b*) Tack-mark the band into four equal portions.

(*c*) Pin the gathered portion across the easel. Place one of the raw edges of the band to the edge of the gathered portion on the wrong side of the material, and regulate the gathers so that the tack marks of the band meet the tack marks of the material.

(*d*) Tack the band in position, afterwards machining it, Fig. 1.

(*e*) Raise the band, lay the turnings inside the band, turn under the remaining raw edge of the band so that the machine stitches are covered, and tack it down over the gathered portion.

(*f*) Machine close to the edge, Fig. 2.

(*g*) If desired, the machine stitching may be done all round the band close to the edge.

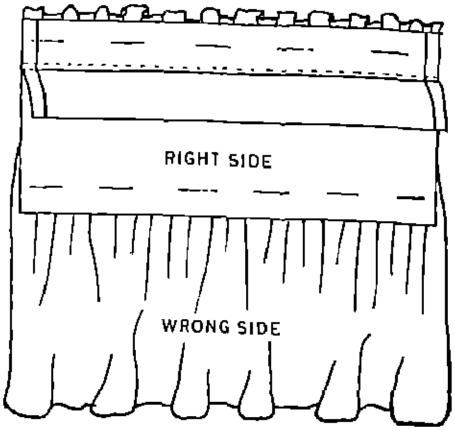


FIG. 1

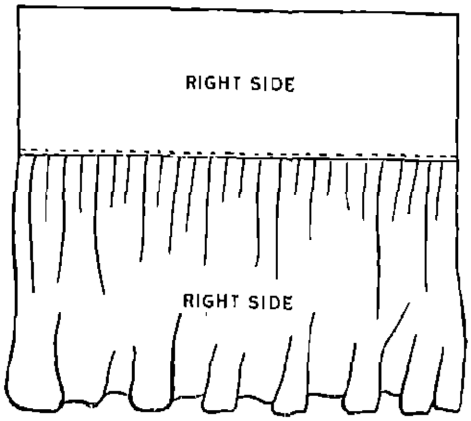


FIG. 2

2. Machining gathers into a fitted portion.—There are three methods of machining in gathers to a fitted part of a garment such as when joining a gathered skirt portion to a bodice portion of a petticoat or dress.

METHOD 1

1. Place the gathered portion, with the gathers distributed evenly, to the fitted portion, having the right sides facing and the edge of the fitted portion about ⅜ in. above the edge of the gathers, Fig. 3.

2. Tack the two together, afterwards machining.

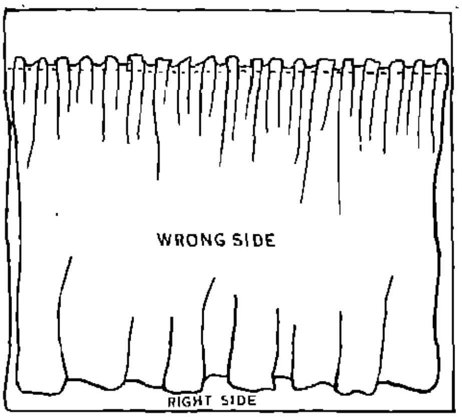


FIG. 3

3. Turn under the raw edges of the fitted part, fold it over the turnings of the previous join so that the turnings and the machining are enclosed, and tack in position.

4. Machine close to the edge and remove all tacking threads, Fig. 4.

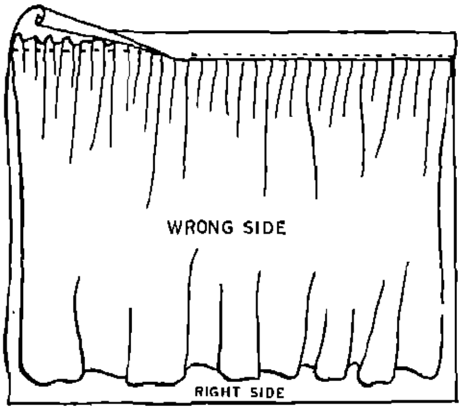


FIG. 4

METHOD 2

1. Place the gathered portion, having the gathers arranged evenly, to the fitted portion with right sides facing and tack the two portions together.

2. Place a crossway strip of material, with the right side to the wrong side of the gathers, and tack in position, Fig. 5.

3. Machine the three thicknesses of material together and remove the tacking threads.

4. Raise the fitting portion and press the turnings flat on to it, holding them in position with a tacking thread, Fig. 6.

5. Raise the crossway strip, turn under the raw edge, and fold the strip over the turnings, machining it flat to the fitted portion, Fig. 7.

METHOD 3

1. Place the gathered portion to the fitted portion, having the right sides facing, and tack together.

2. Place the right side of a crossway strip of material to the wrong side of the gathers, tack in position and machine all three thicknesses together, Fig. 8.

3. Raise the crossway strip and tack flat to the turnings, Fig. 9.

4. Turn under the raw edges of the strip, fold the strip over the turnings so that the turnings and machining are enclosed, and machine close to the edge, Fig. 10.

V. SCALLOPING

Aim of lesson.—To teach the pupils how to beautify the edges of an article or garment.

Arrangement of lesson.—The pupils follow the teacher as she demonstrates, working with her step by step on a sampler which will afterwards be stitched in the notebook.

Teacher's requirements.—A garment having the edges scalloped; a transfer paper of scalloping; an iron and ironing felt; a long strip of paper; coloured pencil; a piece of hessian cut to represent the neck of a petticoat; scissors; a circular piece of cardboard to represent a coin; coloured wools; needle; a chart or blackboard showing the various stages of the lesson.

Children's requirements.—A transfer paper of scalloping; ironing requisites; a long strip of paper; pencil; scissors; halfpenny; needle;

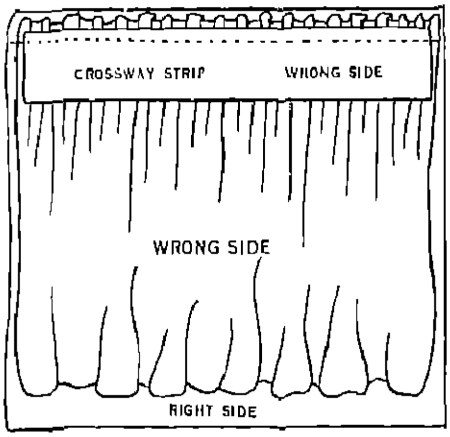


FIG. 5

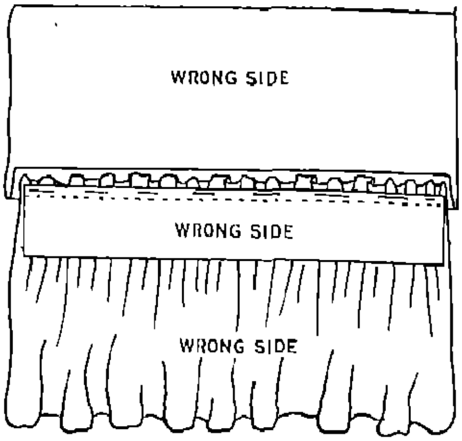


FIG. 6

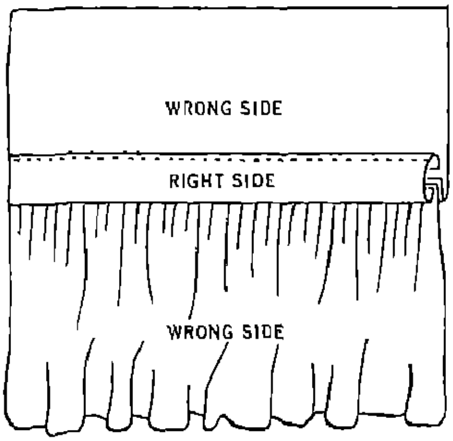


FIG. 7

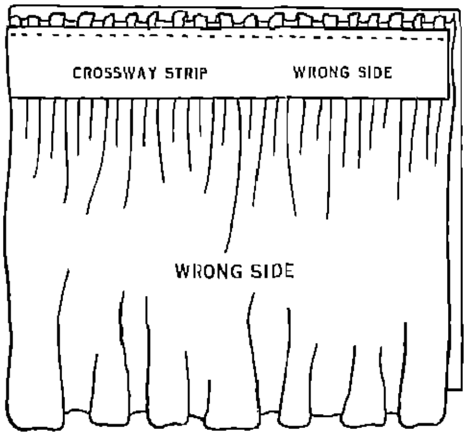


FIG. 8

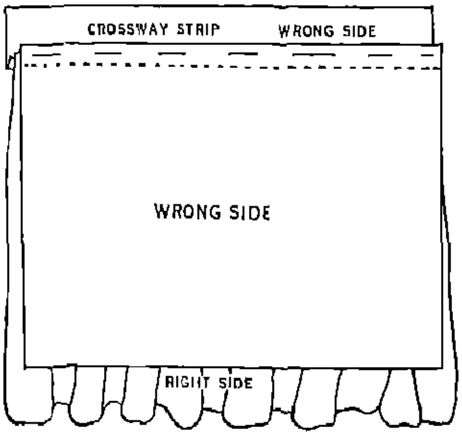


FIG. 9

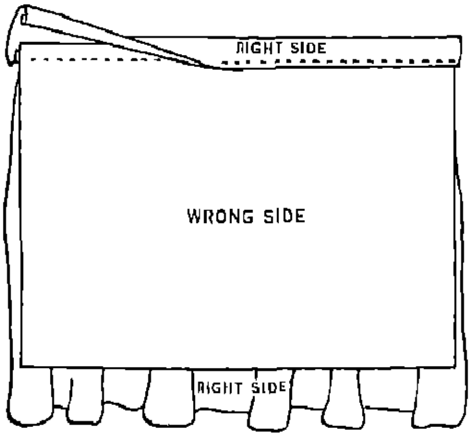


FIG. 10

embroidery cotton; notebook; piece of material cut to represent the neck of a petticoat.

Introduction.—Scalloping is a very popular edging for garments and it is a useful method, being inexpensive, durable, and pleasing to the eye. To finish edges with scallops, the pattern must first be traced on the material. This may be done by one of two methods.

DEMONSTRATION

Method 1

1. Using the bought transfer paper, place it in position along the back curve of the neck about ¼ in. away from the edge. (As *transfer papers are marked in straight lines they need careful manipulation and much snipping to be stamped successfully on curved edges.)* Care should be taken to obtain the right size of scallops to fit the material exactly, so that the scalloping will *not end with a very big or small scallop.*
2. Press a hot iron heavily on the paper and lift quickly.

Method 2

A much more suitable method is to mark the scallops, using a paper guide.

1. Measure the distance to be scalloped; i.e., along the front curve of the neck, mark it on a strip of paper, and cut it off. Divide the length into an even number of scallops. This may be done by folding the paper and rounding off one edge, Figs. 1, 2 and 3. (The whole of the paper need not be used as a guide, a portion only being quite sufficient, the pattern being moved along from stage to stage.)

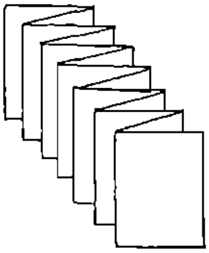


FIG. 1

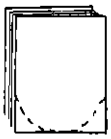


FIG. 2

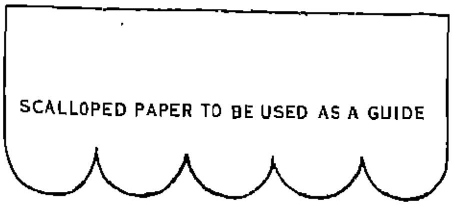


FIG. 3

2. Mark round the pattern with a sharp pointed hard pencil or a line of running stitches, Fig. 4.

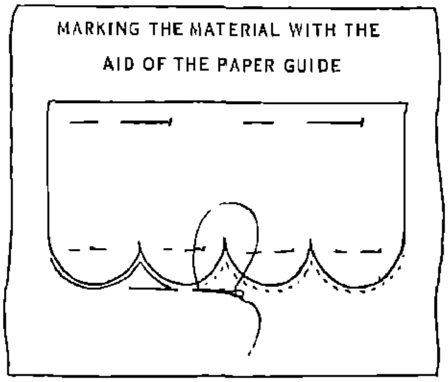


FIG. 4

3. For the second line to be marked, place a halfpenny so that the edge nearly touches both ends of each scallop, and trace round, Fig. 5.

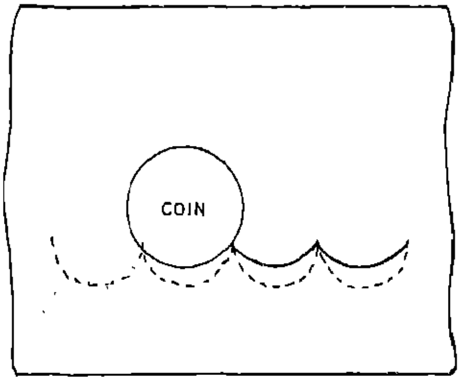


FIG. 5

To work the scallops.—

1. Outline the scallops with running stitches, and if raised work is desired, fill in the scallops with loosely worked running stitches or chain stitches, Fig. 6, care being taken to avoid a bulky appearance at the ends of each scallop.

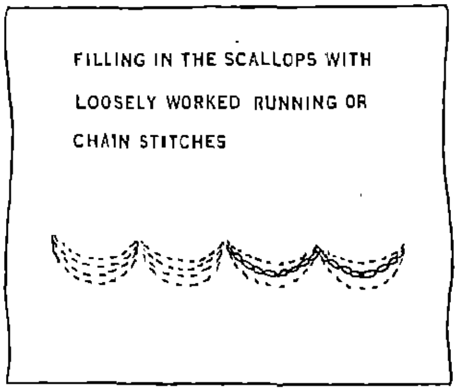


FIG. 6

2. Work blanket stitches very closely over the pattern, the stitches appearing to radiate from an imaginary centre. In the centre of each scallop and where the scallops join, the stitches should be vertical, Fig. 7.

3. When beginning to join or end the blanket stitches, run the thread through the padding stitches on the under side of the material.

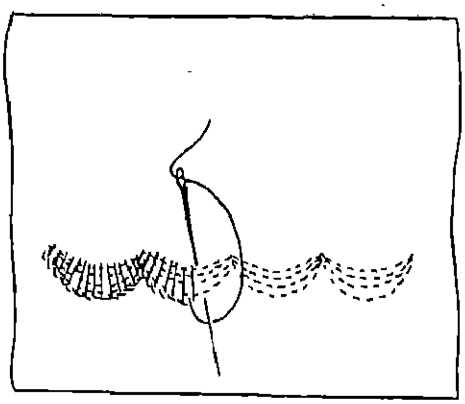


FIG. 7

4. When all the scallops have been worked, cut away the raw edge of the material with a sharp pair of scissors. To do this successfully cut away the material closely behind the twist of the blanket stitch.

BRIEF INSTRUCTIONS FOR THE CONTINUATION OF THE PETTICOAT

Computation of cost.—Kinds of material; widths; prices per yard; quantity required.

Cutting out.—Lay the pattern on the material as in *Fig.* 1 and cut out, allowing ½ in. turnings on all edges and sufficient for the depth of hem required along the bottom edge.

The teacher should use for demonstration purposes a mounted lay as in Fig. 1 and a mounted lay as in Fig. 2 which shows an economical method of cutting out the petticoat, three petticoats instead of two being obtained from four times the length.

Fig. 3 shows the lay of the pattern for the second type of petticoat, and Fig. 4 shows an economical way of cutting out the same petticoat. (This latter method only applies when the bust measurement plus turnings is equal to or less than a quarter the width of material.) The party petticoat is cut out in the same manner.

Brief notes on the draft of the pattern and the cutting out and making up of the petticoat must be made by the pupils in their notebooks whenever opportunity affords.

Making up the petticoat.—Machine the shoulders and under-arm edges to form french seams. An opening is not required in this petticoat, as the lowering of the neck curve allows the garment to slip over the head quite easily. Turn up the hem on the wrong side of the material and machine close to the edge. Neaten the neck and

FRONT PATTERN PLACED TO FOLD OF MATERIAL

BACK PATTERN PLACED TO FOLD OF MATERIAL

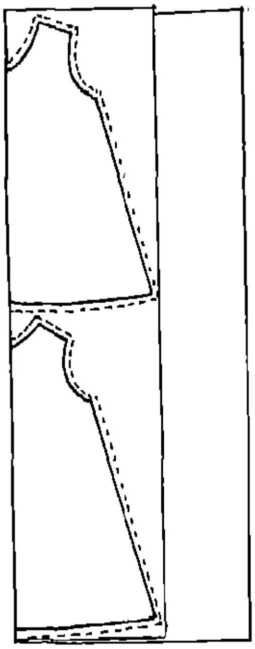


FIG. 1

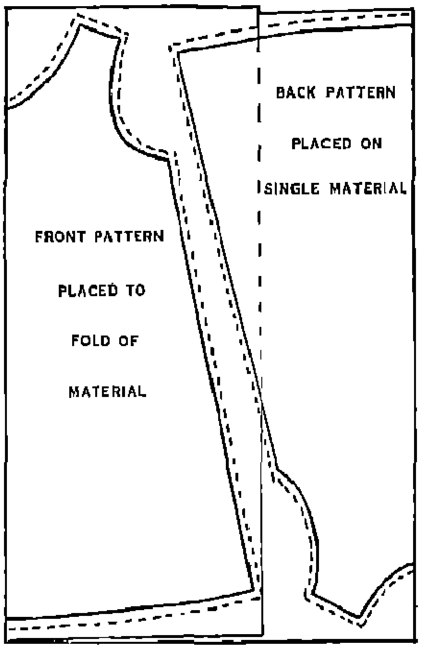


FIG. 2

PATTERN PLACED TO FOLD OF MATERIAL AND FRONT NECK PRICKED THROUGH

PATTERN PLACED TO THE FOLD OF MATERIAL

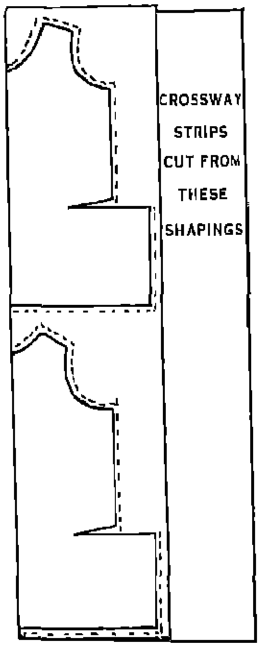


FIG. 3

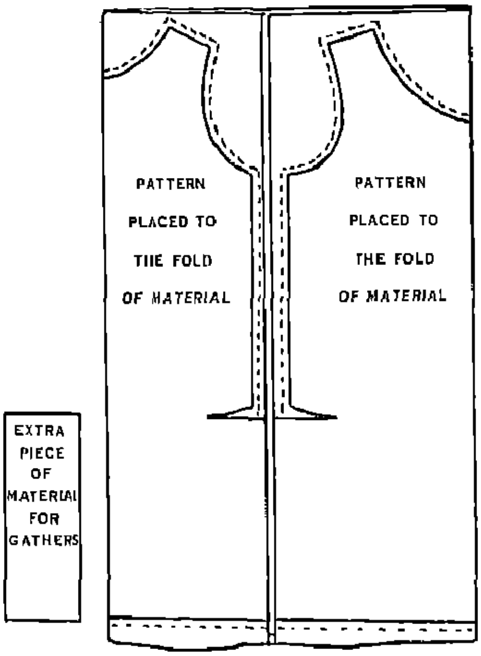


FIG. 4

armhole edges with scallops, or crossway facings which are afterwards embroidered with decorative stitchery; e.g., cross stitching or pekinese stitch. Neaten the slash at the hips using one of the methods already described in Lesson IV. When doing this, the join must be tapered to a fine point at each end, to avoid an ugly pleat in the skirt. If desired, the crossway strip used in Method 2, may be put on the right side of the garment and decorated with stitchery. For the party petticoat, turn a narrow hem along the top edge on the right side of the material, place the lace over this hem, and stitch it to the garment with decorative stitchery; e.g., feather stitching and cross stitching. Attach the shoulder straps.

VI. DECORATIVE STITCHERY

The new stitches suggested for this term are cross stitching; fishbone stitch; pekinese stitch, and stitched chain stitch. The guest towel provides an appropriate article for the illustration of some of these stitches, as well as the petticoats.

Aim of lesson.—The extension of the pupils' knowledge of decorative stitchery.

Arrangement of lesson.—The girls follow the teacher's instructions on a piece of crash as she demonstrates the working of each new stitch.

Teacher's requirements.—Charts showing the different stages in the working of the various stitches; guest towels and petticoats showing the application of these stitches; large piece of crash; coloured wools; needle; scissors; thimble; easel; illustrations of the new stitches drawn in bold sketches on the blackboard in coloured chalks; drawing pins.

Children's requirements.—A piece of crash; embroidery cotton or wools; needle; thimble; scissors; notebook.

DEMONSTRATION

Cross stitching.—Cross stitch owes its beauty to the regularity with which it is worked. As a guide at the beginning, two very faint pencil lines may be drawn equal distances apart. Cross stitching is worked in two "journeys," the first half of the stitch being worked entirely along a line from left to right, and the crossing-over done from right to left on the return journey.

1. Pin the crash across the easel. Begin at the left-hand side by passing the needle through from back to front at the end of the bottom line. (The loose thread is afterwards darned in at the back of the stitches.)

2. Work a line of slanting tacking stitches, Fig. 1.

3. Work another line in the opposite direction to cross the previous stitches, the needle in the second row passing in and out through the same holes as those in the first journey, Fig. 2.

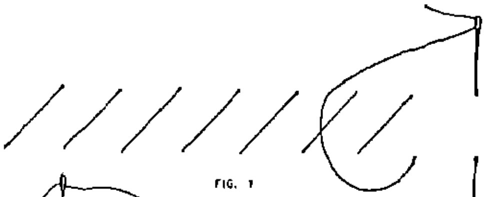


FIG. 1

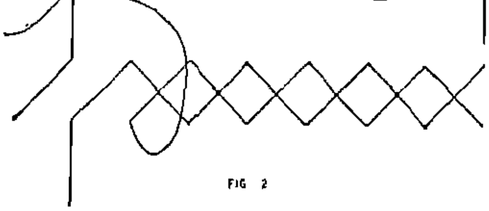


FIG 2

Fishbone stitch.—Fishbone stitch is worked vertically from top to bottom, and provides a useful border stitch when openly spaced as in Figs. 1A and 1B, or closely worked together to give a solid effect as in Fig. 2.

1. Begin by drawing a faint line down the crash. Pass the needle through from back to front, a little to the left of this line.

2. Make a slanting tacking stitch upwards over the line to the right, and pass the needle through on the left again on a level

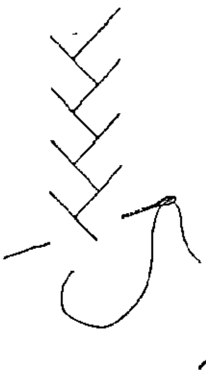


FIG. 1A

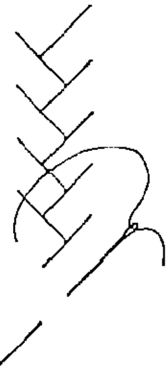


FIG. 1B

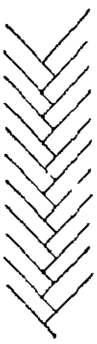


FIG. 2

with half the length of the tacking stitch and twice as far from the line as the point where the stitchery began, Fig. 1A.

3. Making a slanting tacking stitch downwards to the right, bringing the needle out slightly to the left of the line, Fig. 1B. Repeat these two operations.

Pekinese stitch.—This border stitch is worked in two colours of embroidery cottons, the first row being worked from right to left and the second row from left to right.

1. Make a line of close stitching in one colour of wool.

2. Thread the second colour of wool upwards through the second stitch and bring it down again through the first stitch as in Fig. 1.

Stitched chain stitch.—This is a variation of the simple chain stitch, and makes a very effective border when worked in two colours of embroidery cottons.

1. Work a line of chain stitch in one colour of wool.

2. Stitch over each "link" in another colour of wool, Fig. 2.

VII. REPAIR WORK

The repair work has now reached a more advanced stage and more difficult forms of patching for dress materials are to be dealt with during this term.

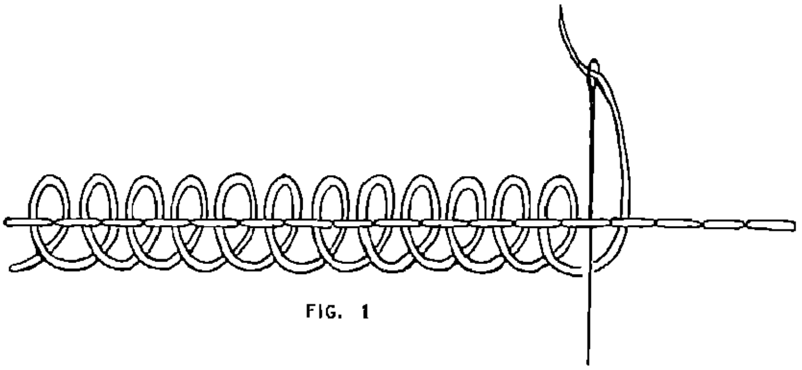


FIG. 1

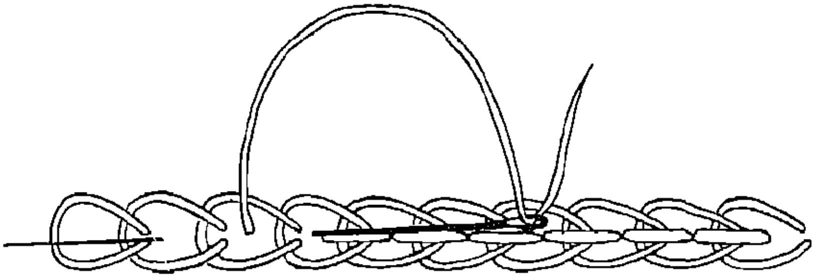


FIG. 2

Arrangement of lesson.—While the lesson is being given the pupils will practise the principles on pieces of material, afterwards mounting them in their notebooks. The knowledge gained will be applied to their own garments later.

Teacher's requirements.—Large pieces of material suitable for demonstrating the different kinds of patch; i.e., woollen and cloth dress materials; garments which have already been repaired with the various kinds of patches; charts showing the different stages in the various forms of patching; coloured wools; needle; pins; scissors; thimble; easel; drawing pins.

Children's requirements.—Pieces of material which require patching; smaller pieces from which to cut the patches; needle; cotton; pins; scissors; thimble.

Introduction.—Refer to the rules for patching given in the first term.

DEMONSTRATION

Variation of the woollen patch.—When this patch is required for dress material, if herring-boning is done on the right side, the patching would become very conspicuous. This difficulty is overcome by replacing the herring-boning by short lines of darning. These stitches are much less noticeable as they lie in the same direction as the threads of the material. It is quite suitable for the herring-boning to be done on the wrong side of the patch as the smaller stitches on the right side are more or less "lost" in the threads of the material.

1. Arrange the patch as for the flannel patch, herring-boning it down on the wrong side of the material.

2. Work short rows of darning stitch over the right side of the patch, drawing the loops at the end of each line through to the wrong side so as to render them invisible, Fig. 1.

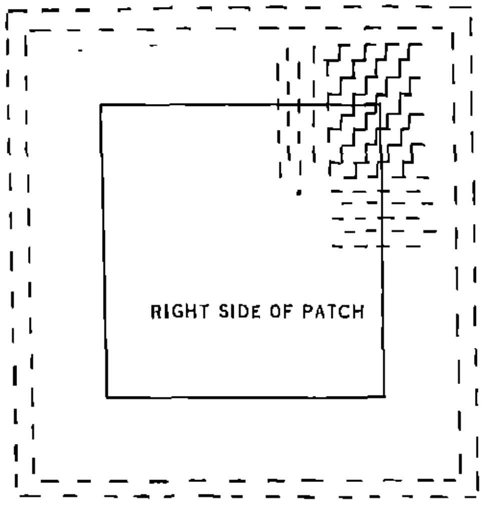


FIG. 1

Cloth patch.—The following are two ways of making a cloth patch.

METHOD I

1. Prepare the patch (noting the way of the threads and the pattern, if any) by cutting a piece of material large enough to cover the hole, the worn part and $\frac{3}{8}$ in. to $\frac{1}{2}$ in. turnings.

2. Cut away the superfluous material at each corner as described in *Repair Work* for the First Term, so that a diagonal line joins the turnings across the corners of the patch, Fig. 1.

3. Prepare the hole by cutting away the worn part, allowing $\frac{3}{8}$ in. to $\frac{1}{2}$ in. turnings so that the hole and the patch are exactly the same size; i.e., AB equals A^1B^1. Cut up the turnings diagonally at each corner and tack the turnings down flat on the wrong side of the material, Fig. 2.

4. Place the patch inside the hole with the wrong side of both uppermost, taking care that the corners fit. Sew the patch and material together, keeping the patch

always to the worker and sewing the selvedge sides first. When the first selvedge has been sewn, leave the end of the cotton hanging to proceed with the weft side after the second selvedge side and one weft side have been sewn, Fig. 3.

5. Remove the tacking threads, and blanket-stitch the turnings, Fig. 4.

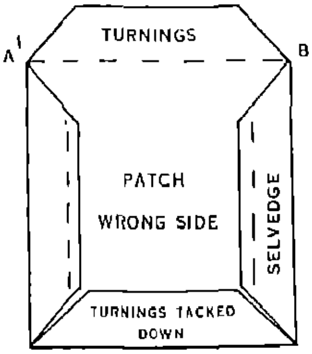


FIG I

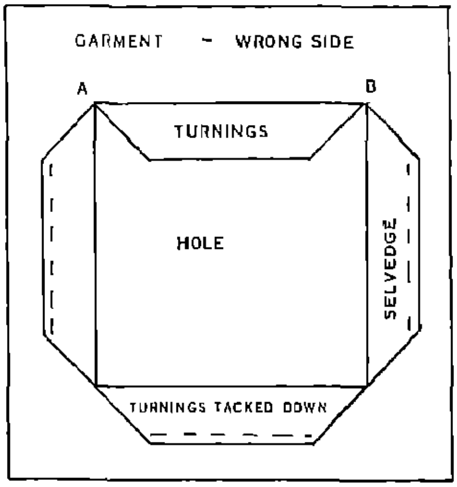


FIG. 2

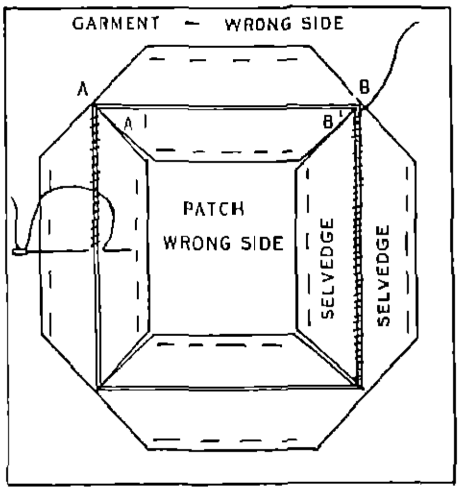


FIG. 3

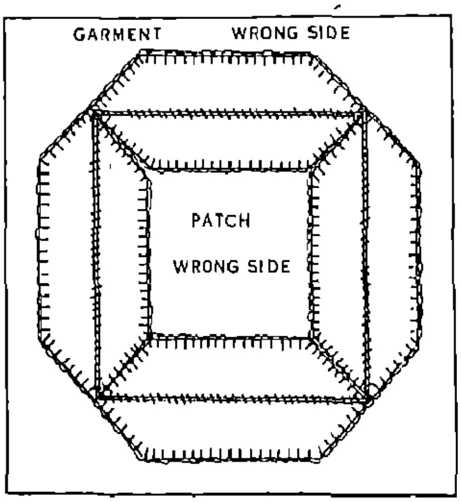


FIG. 4

METHOD 2

1. Mark with a tacking thread on the material the size of the patch required.
2. Cut away the worn part, allowing ⅜ in. to ½ in. turnings, and cut the turnings diagonally to each corner, Fig. 1.
3. Make a paper pattern the size of the patch required and use it for cutting out the patch so that the patch and the hole are exactly equal in size; i.e., AB equals A^1B^1. (Note the way of the threads and the

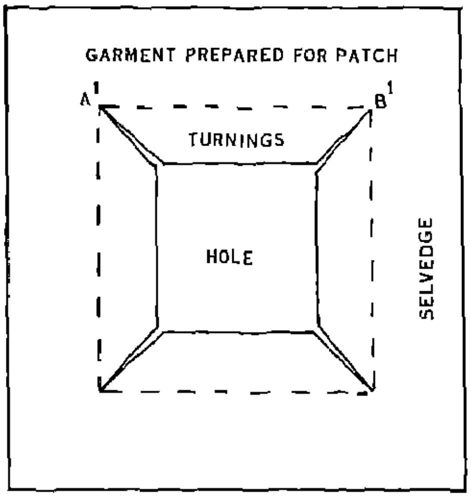


FIG. 1

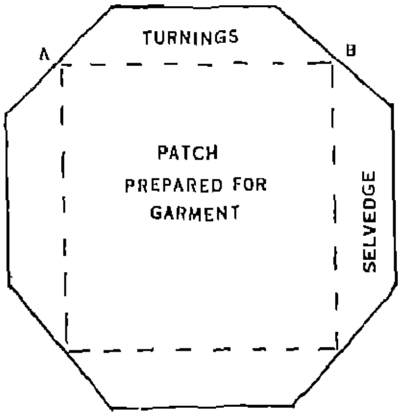


FIG. 2

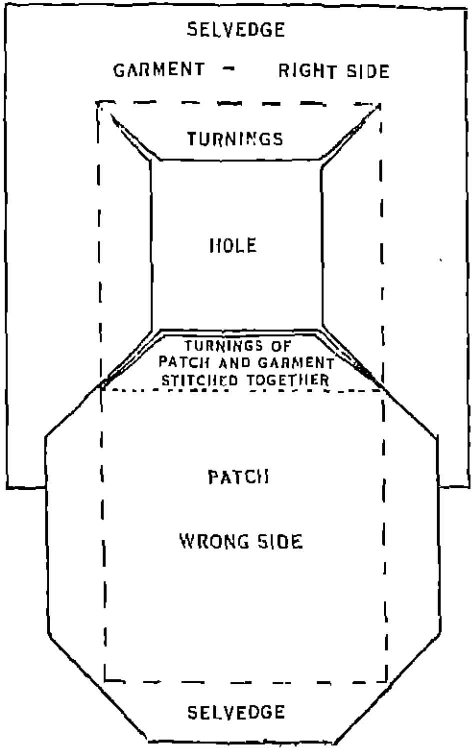


FIG. 3

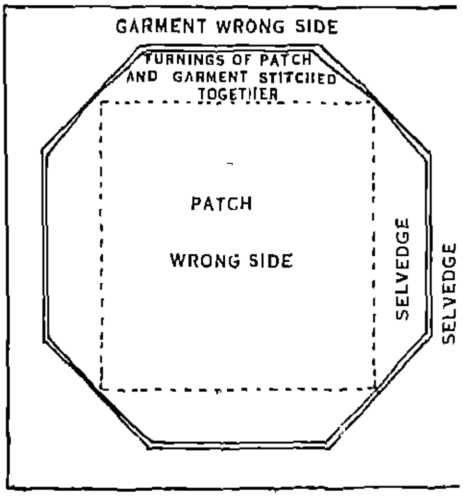


FIG. 4

pattern, if any.) Place a tacking thread to mark the pattern and cut out, allowing turnings.

4. Cut away the superfluous material at each corner, Fig. 2.

5. Place the right side of the patch on the right side of the material, so that the turnings of one selvedge-way of the patch lie on the turnings of one selvedge-way of the hole, Fig. 3.

6. Stitch the two lots of turnings together along the tacking line.

7. Take the patch through the hole to the wrong side and stitch the remaining three sides in the same way, working the second selvedge side before the weft side, Fig. 4.

8. Press the turnings flat open and blanket stitch the raw edges, Fig. 5.

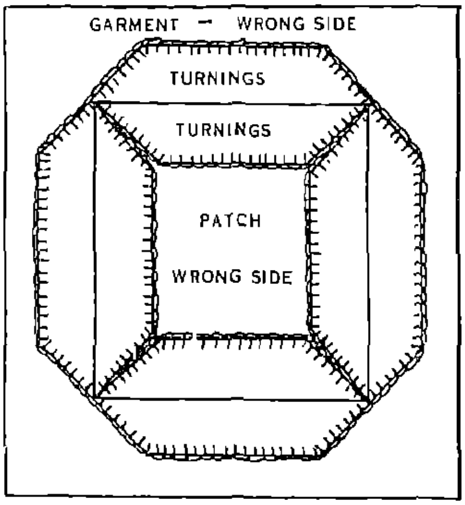
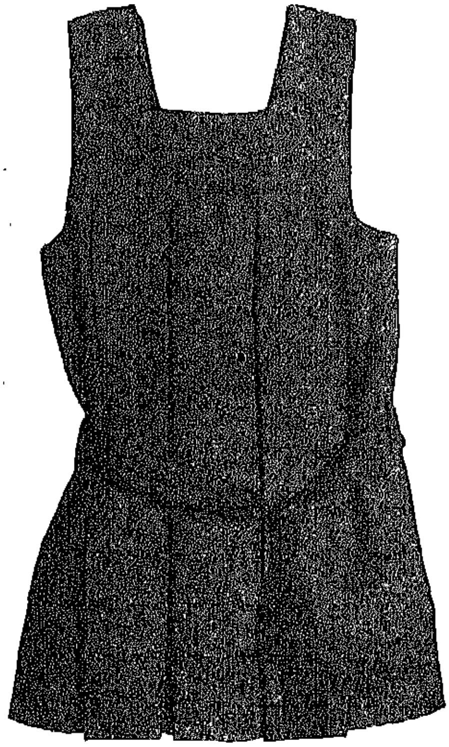


FIG. 5



DRILL TUNIC

FIRST YEAR COURSE —THIRD TERM

Pattern making.—Yokes.

Garment or article to be made.—Drill tunic; needlework bag or linen bag completed.

Knitting.—Gauntlet gloves.

Processes.—Neatening of seams; reducing fullness by means of pleats.

Decorative stitchery.—Application of the stitches learnt in the first and second terms.

Repair work.—Patches in difficult positions.

Discussion of work.—Using patterns of the various kinds of yoke, reference must be made to their formation from the bodice pattern. A drill tunic and one or two blouses showing different types of yokes provide suitable illustrations of the yoked type of garment.

Attention must be drawn to the method of neatening the seams of the drill tunic and a comparison made with the methods used previously.

The decorative article should be on view for reference purposes, also the gauntlet gloves for the completion of the knitted set.

Garments having the worn parts or holes in awkward places will prove the necessity for an extension of the knowledge of repair work.

After the discussion of the work, the chief features of the yoke pattern may be noted. A yoke is the shoulder portion of a garment forming a support for the remainder of the garment. It is obtained from the upper portion of the bodice pattern, and may have the shoulder seam as in the bodice, or it may be arranged without a seam. When the yoke is cut in one piece it is known as a saddle yoke. The depth of the yoke varies according to taste and the style of garment for which it is intended; e.g.:—

1. The front and back portions may be equal in depth.

2. The front portion may be less than the back portion, being cut almost parallel to the shoulder line and about 1 in. or 2 in. in front of it.

3. The back portion may be less than the front portions, being only about 1 in. behind the shoulder line. In this case the front portions are usually about 2 in. in front of the shoulder line, and the yoke is known as a shoulder yoke.

4. In some cases a "yoke" effect may be obtained without having an actual yoke. A portion of the front bodice pattern is cut away from the shoulder to the depth required for the "yoke." This piece is added to the back bodice pattern and cut without having a shoulder seam. The bottom edges of yokes may differ in shape; e.g., rounded, square, or pointed, but in each case the remainder of the garment is shaped to match the yoke.

I. HOW TO OBTAIN DIFFERENT TYPES OF YOKE

Arrangement of lesson.—As the teacher demonstrates the making of these yokes, the pupils will make their own patterns, following her step by step.

Teacher's requirements.—Patterns of various kinds of yoke; bodice pattern; sheets of drafting paper; tracing wheel; coloured pencils; drawing pins; blackboard; chart showing illustrations of the different types of yoke.

Children's requirements.—Bodice pattern; sheets of drafting paper; tracing wheel; pencil; scissors; notebook.

DEMONSTRATION

A saddle yoke.—

1. Fold a sheet of drafting paper and lay the bodice pattern on it with the centre back to the fold and the shoulder lines touching each other, Fig. 1.

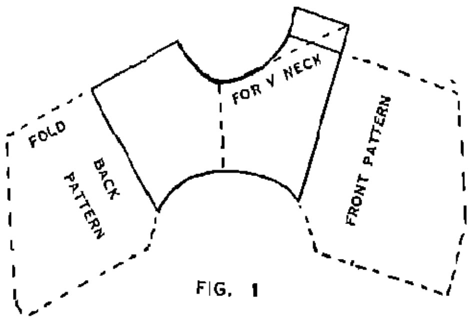


FIG. 1

2. Allow ½ in. for a wrap at the centre front for fastening.

3. Make the yoke the depth required.

4. Alter for a V-neck if required.

5. Mark the pattern with a tracing wheel along the altered lines and the neck and armhole lines.

6. Remove the bodice pattern and cut

out, Fig. 2. (The dotted line shows the V-neck line.)

If the yoke is required to fasten down the centre back, the same processes are carried out after placing the centre front of the bodice pattern to the fold.

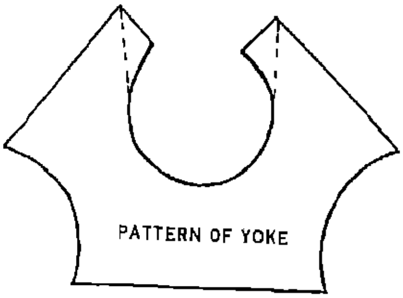


FIG. 2

Different styles of yoke.—Figs. 3 to 12 show the methods of obtaining different styles of yoke. Make and cut out patterns of all the styles:—

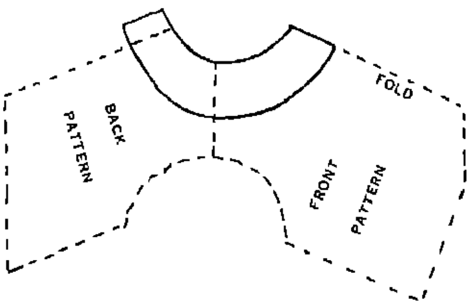


FIG. 3

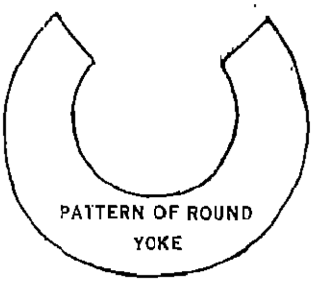


FIG. 4

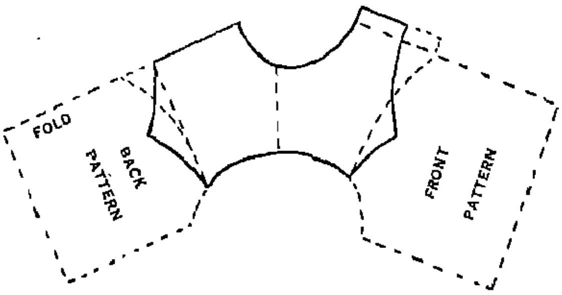


FIG. 5

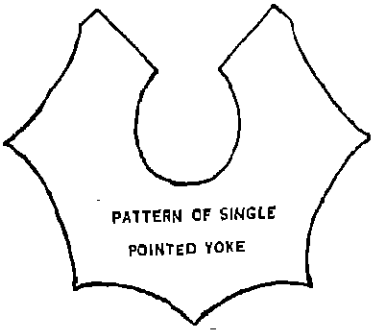


FIG. 6

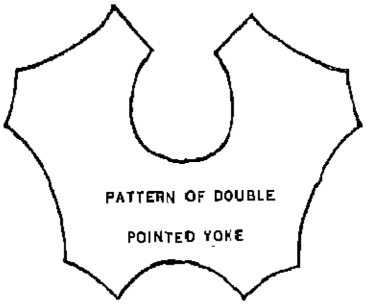


FIG. 7

Saddle yoke with rounded lower edge, Figs. 3 and 4.

Saddle yoke with lower edge pointed, Figs. 5, 6 and 7.

Square yoke for a drill tunic allowing for wrap where required, Figs. 8 and 9.

Yoke when depths of front and back are different, Figs. 10 and 11.

Portion of front bodice cut away and attached to the back to form an imitation yoke, Fig. 12.

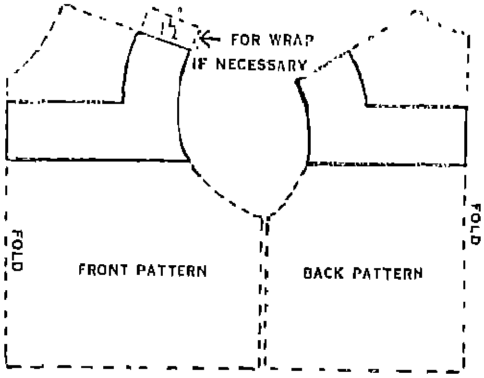


FIG. 8

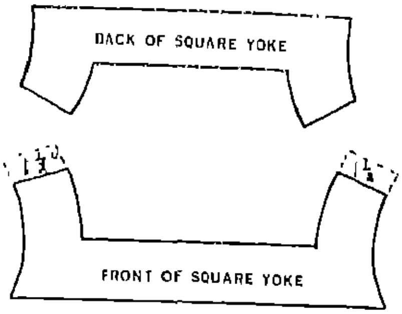


FIG. 9

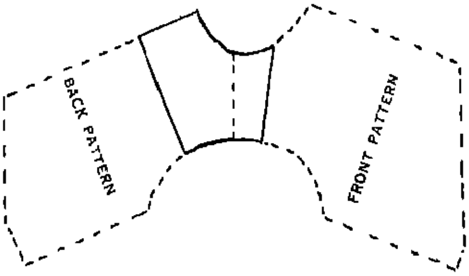


FIG. 10

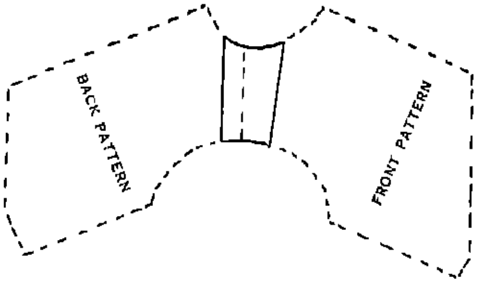


FIG. 11

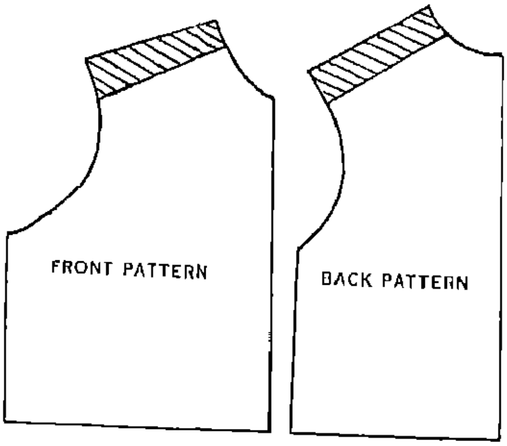


FIG. 12

II. PLEATING

Pleating is a simple way of disposing of fullness, the success of this method depending upon careful folding and preparation. Pleats are usually arranged in woollen materials which do not require constant washing (the pleats being closed at the top do not admit the iron very well), and which if gathered would present a bulky appearance when finished.

Pleats must be folded in regularly, must not overlap each other, and must be arranged on both the right and left sides of a centre line, either facing towards or away from the centre. They may be placed touching each other, or they may have a space between each pleat.

A pleat takes up three times its width—the upper part, the under part, and the part on which it falls. So that the pupils will be able to master this principle easily, it is advisable to allow them to practise pleating first on paper.

Aim of lesson.—To teach the pupils how to pleat correctly.

Arrangement of lesson.—As the teacher demonstrates the pleating, the pupils follow each process step by step with their own "material."

Teacher's requirements.—A drill tunic showing the application of pleating on a garment; strips of paper pleated; strips of paper for pleating; coloured pencils; drawing pins; blackboard; chart showing the different stages in pleating; pins; ruler; wide pieces of paper and a cardboard gauge.

Children's requirements.—Narrow strips of paper; wide pieces of paper; pencil; ruler; pins; notebook.

DEMONSTRATION

Pleats touching each other.—

1. *Divide the strip of paper into ½ in. portions* and mark the divisions lightly in pencil.

2. Place a pin to denote the centre line and from this line letter the spaces on each side in order, A, B, and C, repeating the lettering to each end of the paper, Fig. 1.

3. Fold the paper on the line between A and B so that B falls under A.

4. Fold the paper again on the line between B and C so that C falls under B, and the first fold falls on the line between C and the second A.

5. Continue with this to each end of the paper from the centre line, so that when the paper is completely pleated the letter A shows in every space, Fig. 2.

6. If it is desired that the pleats face towards the centre line, then the paper is folded so that B lies above A, and C lies about B, the paper showing a line of C's when completely pleated.

Pleats separated with a space.—

1. Divide the strip of paper into ½ in. portions.

2. Letter the centre space D, and on each side of this space letter the remaining spaces A, B, C and D respectively, repeating the letters to each end of the paper, Fig. 3.

3. Fold the paper as before so that B falls under A and C falls under B. Continue to each end of the paper.

4. In this case, when the pleating is complete, the letters showing, reading from the centre, will be a repetition of D and A, Fig. 4, letter D denoting the spaces between the pleats which are denoted by letter A.

5. If the pleats are to lie facing the centre, space B falls over A and C over B, a repetition of the letters DC being seen on each side of the centre space when the pleating is completed. When the pupils are sufficiently sure of the principle of pleating, then they may be taught how to arrange the pleats for garments.

Methods of arranging pleats.—There are two ways of arranging pleats: (1) By using *a strip of paper*; (2) By using a cardboard gauge.

METHOD I

1. Take a strip of paper A, equal in length to the material to be pleated, and a second strip B, equal in length to that part of the garment into which the pleats are to be fitted.

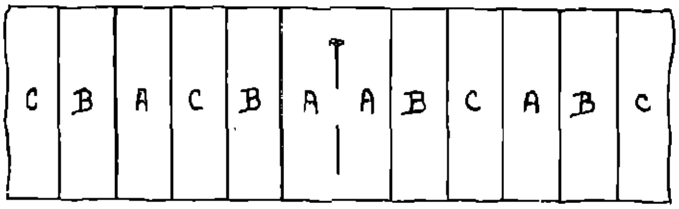


FIG. 1

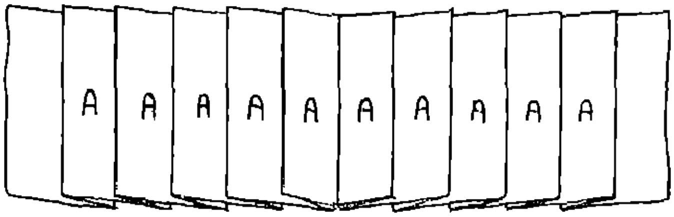


FIG. 2

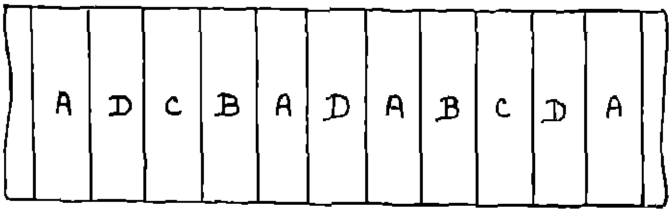


FIG. 3

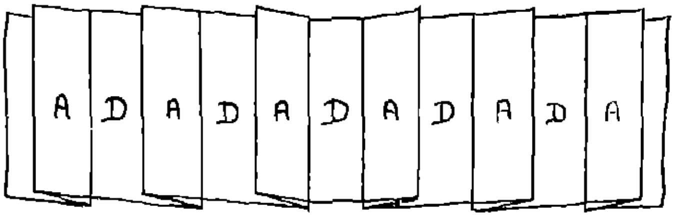


FIG. 4

2. Subtract the length of strip B from the length of strip A to find the amount of the surplus material to be pleated; e.g., if strip A equals 9 in. and strip B equals 3 in., then the amount to form two-thirds of the pleats will be 6 in. The pleats therefore may be arranged in six $\frac{1}{2}$ in. pleats or twelve $\frac{1}{4}$ in. pleats, etc., according to taste.

3. Mark the centre of strips A and B, and arrange one-half of strip A into the required number of pleats to fit into one-half of strip B.

4. Arrange the remaining half of strip A

into the remaining half of strip B so that the pleats fall in the direction opposite to those in the first half, if so desired.

5. Where the paper is folded on the outside to form the pleats, place a pin, and where the paper is folded on the inside, mark with a dotted line, Fig. 5. Mark with a dotted line the place where the outside fold falls.

6. Open out the pleated paper and lay it on the material to be pleated, about $\frac{1}{4}$ in. away from the edge, Fig. 6.

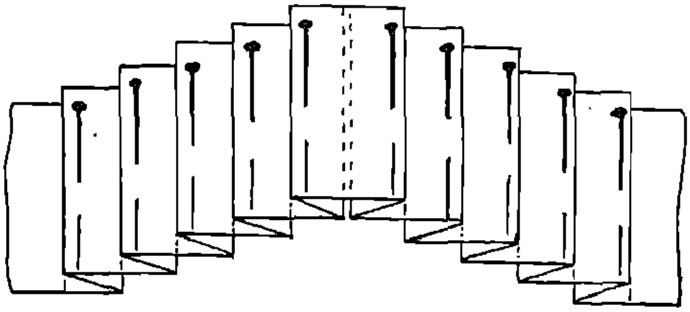


FIG. 5

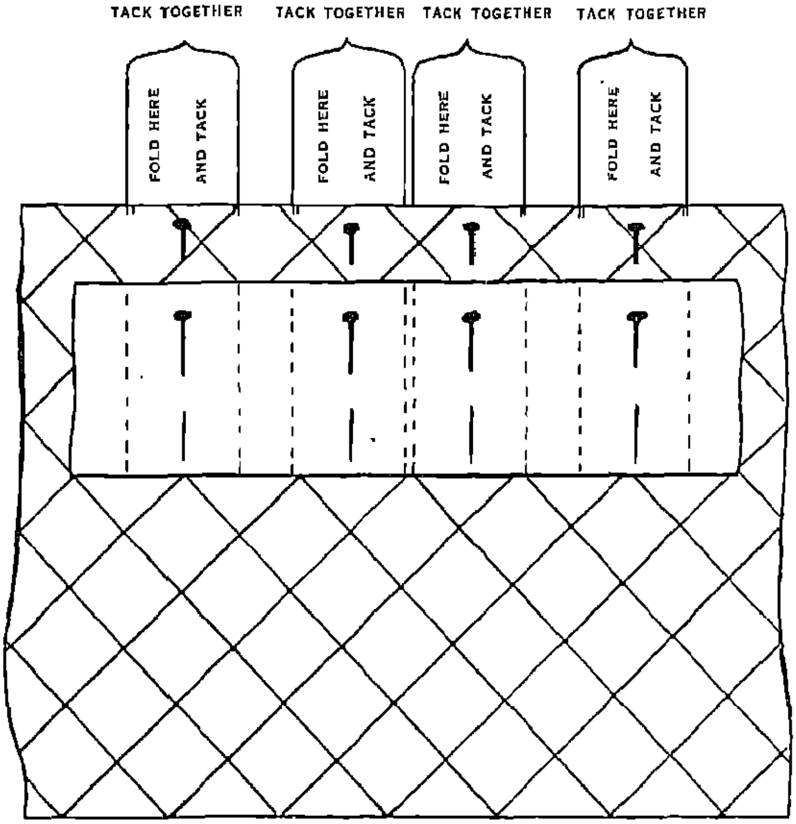


FIG. 6

7. Place pins on the material opposite the pins on the paper and tack-mark where the dotted lines fall, Fig. 6.

8. Remove the paper. Where the pins fall, fold the material and tack close to the edge. Place the tack marks together on each side of the pins and tack through the two thicknesses of material, Fig. 7.

9. If the pleats continue to the hem of the garment, as in skirts and drill tunics, it is advisable to place the paper guide along the bottom of the garment also, so that the pleats will lie in perfectly straight, even lines when tacked from top to bottom of the garment.

METHOD 2

This method is suitable when a very wide piece of material has to be pleated.

1. Calculate the width of each pleat from the amount of material to be pleated, and make the gauge to fit the size of pleat required, Fig. 8. If a space between each pleat is desired, then this position is denoted on the gauge as in Fig. 9.

2. Mark the centre line of the material. Fold the material wrong side to wrong side

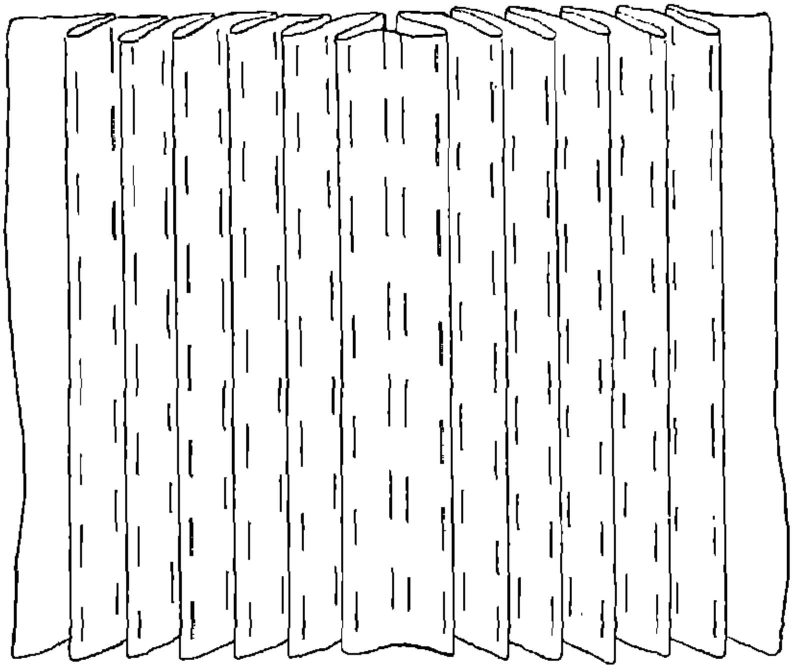


FIG. 7

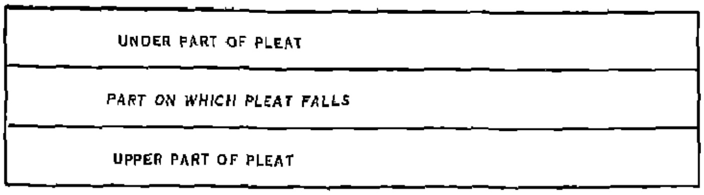


FIG. 8

where the first pleat has to be made, and tack close to the edge, Fig. 10. Work with the under side of the pleat towards the worker.

3. Place the gauge in position and tack the pleat in position where shown by the gauge, Fig. 10. The end of the cardboard denotes the place where the fold for the next pleat must be made. Continue as before, Fig. 10.

4. If the cardboard gauge is moved along the length of material, it serves as a guide for straight folding and tacking for the required length of pleats, Fig. 10.

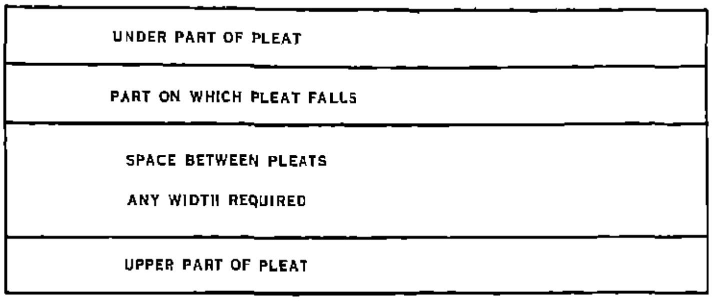


FIG. 9

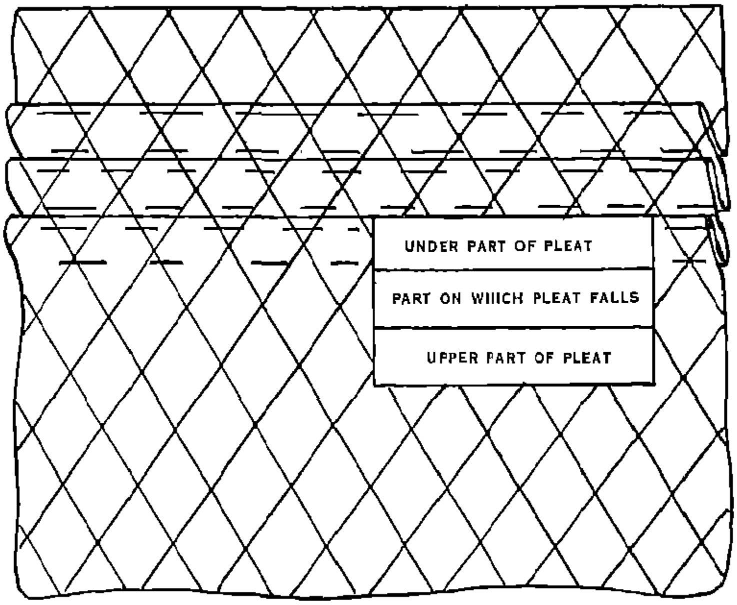


FIG. 10

III. OBTAINING THE PATTERN OF THE DRILL TUNIC

Arrangement of lesson.—The teacher demonstrates how to obtain the pattern, the girls following her step by step to obtain their own pattern.

Teacher's requirements.—A completed drill tunic; bodice pattern; sheets of drafting paper; coloured pencils; ruler; drawing pins; blackboard showing the method of obtaining the pattern; scissors; tape measure.

Children's requirements.—Bodice pattern; sheets of drafting paper; pencil; ruler; tape measure; scissors; notebook.

DEMONSTRATION

Measurements required.—Depth of yoke from shoulder to bottom edge; width of yoke; length from the bottom of the yoke to the knee or shorter if desired; width around the bottom of the tunic—(1) front width, and (2) back width. The width across the bottom may be determined in the following manner.

Front width.—Measure the length of the base of the front yoke. Subtract the amount to be allowed at each end of the yoke for the material to be set in plainly. This leaves the length into which the material of the tunic has to be pleated, therefore the amount of material for pleats alone must be three times this length if the pleats have to touch each other, which is usually the case in drill tunics.

The total width of material for the bottom of the tunic will therefore be the amount to be pleated plus allowance for setting in plainly at each end of the yoke, plus twice (the width of the armhole curve plus 1 in.) for the shaping of the side seam; i.e., LB in Fig. 1.

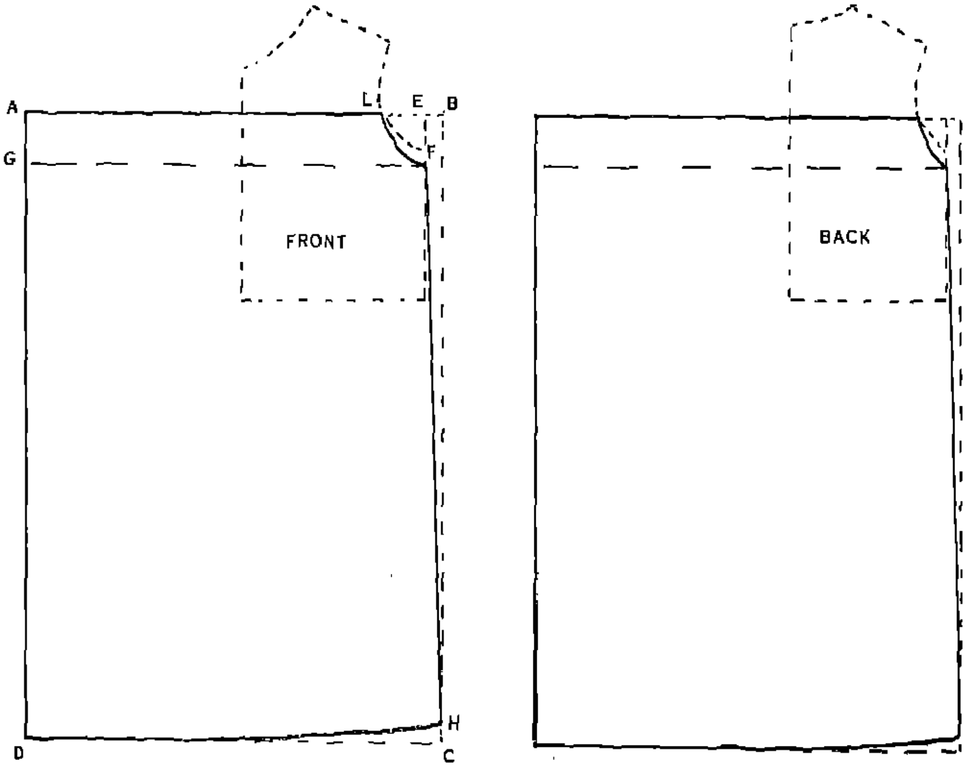


FIG. 1

Suppose the length of the bottom of the front yoke is 13 in., allowance for setting in plainly is 1½ in. and the width of the armhole curve is 2½ in., then the width of the bottom of the tunic will be:—3(13 in.—3 in.) plus 3 in. plus 2(2½ in.+1 in.), which is 40 in.

Back width.—As the pleats in the back portion of the tunic must correspond in size to those of the front portion, the allowance for setting in plainly at the back of the yoke will be less than the allowance at the front according to the difference in the lengths of the bottom of the back and front yokes; e.g., in the example quoted above, if the bottom of the back yoke measures 12 in., then, as the allowance for pleating must be the same as for the front, 1 in. only must be set in plainly at each end. The width at the bottom for the back of the tunic will be: 3(12 in.—2 in.) plus 2 in. plus 2(2½ in.+1 in.), which is 39 in.

Drafting the pattern.—

1. Using the bodice pattern, make a square yoke for a drill tunic as previously described, the usual width of such a yoke being from 2 in. to 2½ in.
2. Draw an oblong ABCD, Fig. 1. AB equals half the front width across the bottom of the tunic. BC equals the length from the bottom of the yoke to the knee. BE equals 1 in. Using the remainder of the bodice pattern not included in the yoke, place the line indicating the base of the yoke along AB so that the under-arm line lies perpendicular to E.
3. Lower the armhole 1 in., F. Join FC. FH=GD to avoid a dip at the sides. Join DH with a curved line.
4. Using the back of the bodice pattern, obtain the back pattern of the tunic in the same way. Cut out on the pattern lines, Fig. 1.

IV. NEATENING OF SEAMS

Where a garment is made up of material which is too thick a texture to admit of a seam being made in it to enclose the raw edges, a plain or single seam is made. The edges are then separated and the seam pressed out flat to ensure a neat appearance when the garment is finished. To prevent the raw edges of the seam fraying they may be neatened by one of four methods; viz., *pinking or gimping; overcasting;* edges turned; binding.

Arrangement of lesson.—The girls work along with the teacher as she demonstrates the working of each method.

Teacher's requirements.—A completed drill tunic having the seams neatened by the four methods; three pieces of hessian; scissors; coloured wools; needle; easel; drawing pins; crossway strip of material; thimble.

Children's requirements.—Three pieces of material about 2½ in. by 6 in.; a crossway strip of material 6 in. long; needle; cotton; scissors; thimble; notebook.

DEMONSTRATION

Join the three pieces of material together to form two seams with ½ in. wide turnings. On one side of each seam work one of the following methods of neatening.

Pinking or gimping.—Take one raw edge of the seam, fold it over every ½ in. and snip to the depth of about ¼ in., Fig. 1, p. 254.

Overcasting.—This stitch is worked from left to right on one raw edge of the seam on the right or wrong side of the material, and is something like over sewing.

1. Begin at the left side by making a few running stitches in the opposite direction to that in which the stitches are worked, these stitches being afterwards covered by the overcasting stitches, Fig. 2.
2. The stiches must be uniform, not drawn too tightly or placed farther apart than they are deep.
3. When ending, bring the needle out on the wrong side, run it under the last few stitches made, and make a back stitch.

Edges turned.—Fold the raw edge under a little on the wrong side and machine-stitch, Fig. 3. When this method is used it is as well to allow ¾ in. turnings for the seam.

Binding.—The crossway strip should be of lining to tone with the material of the garment.

1. Place the right side of the strip to the right side of the turnings, edge to edge, and machine-stitch about ¼ in away from the edge.

2. Turn the crossway strip over to the wrong side of the material, fold under the edge, and hem down on the turnings of the first join, Fig. 4.

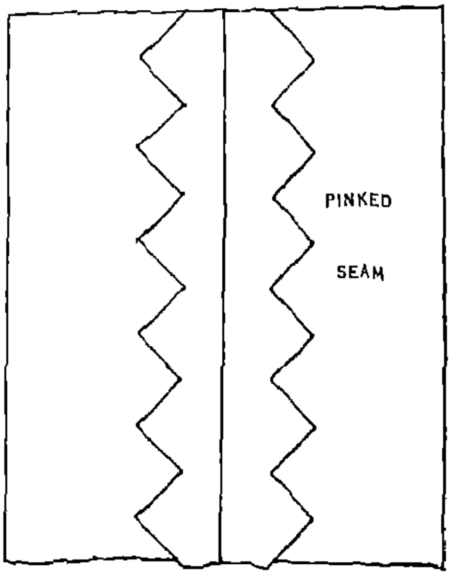


FIG. 1

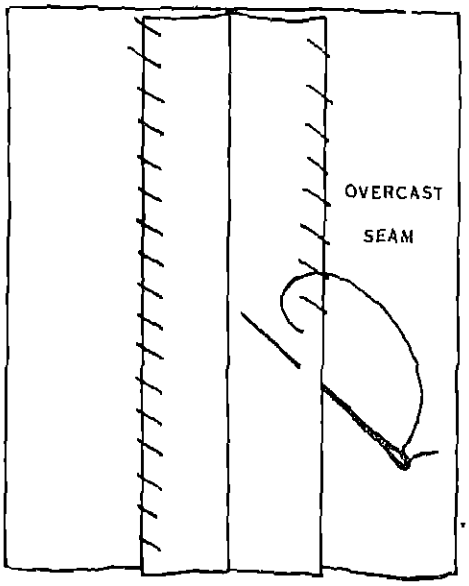


FIG. 2

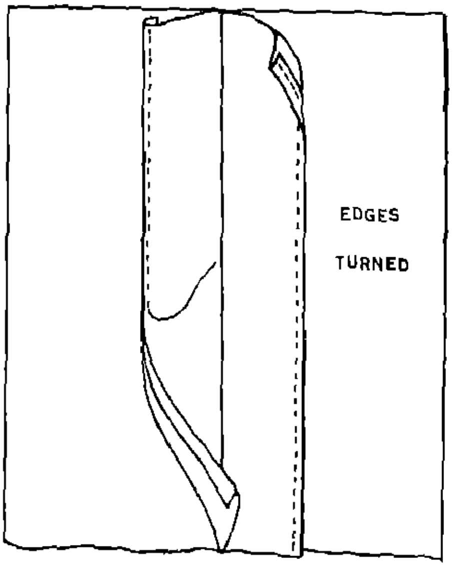


FIG. 3

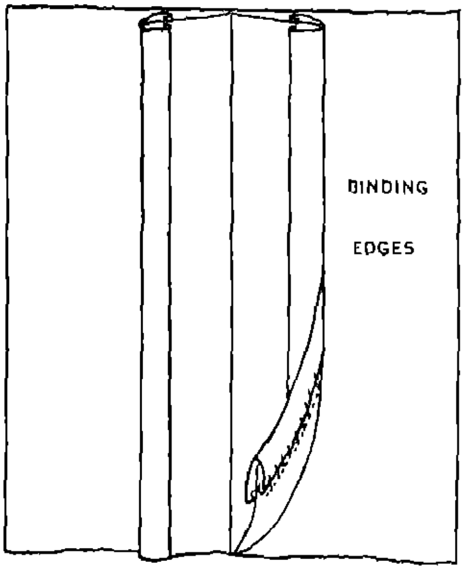


FIG. 4

BRIEF INSTRUCTIONS FOR THE CONTINUATION OF THE DRILL TUNIC

Computation of cost.—Kinds of material; widths; prices per yard; quantity required.

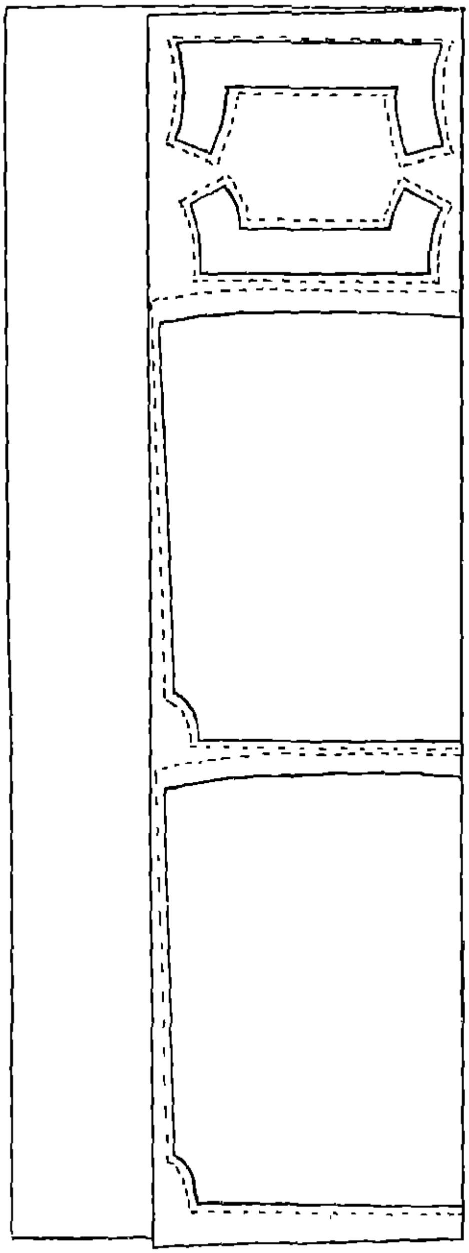


FIG. 1

Cutting out.—Lay the tunic and yoke patterns on the material as in Fig. 1, and cut out, allowing ½ in. turnings along the *top edge*; ⅜ in. or ½ in. *turnings along the* side edges (this depends on the manner in which the seams are neatened); 3 in. turnings along the bottom edge for the hem, and ½ in. *turnings on the edges of the yoke*, unless it requires a wrap when 1½ in. turnings must be allowed on either the front or back shoulder lines.

Making up the tunic.—Join together each front and back yoke along the shoulder line and press the seams flat. Lay the two yokes together, right sides facing, and machine-stitch all round the inside edges. Snip the turnings at each corner, turn the yoke inside out, and tack along the joined edge, afterwards machining close to the edge. Turn under the ½ in. turnings on all outside edges and tack. Join the side edges of the tunic to form a single seam and neaten the raw edges. Measure 3 in. from the bottom edge and turn up the material to form the hem, tacking the fold to keep it in position. Allow the hem to "fall" naturally in its own position, and, where it lies flat on the material, pin through. Where any fullness occurs, lay the material in a small fold and pin, Fig. 2. Tack along the bottom edge, afterwards herring-boning the hem in position to single threads of the material, Fig. 3. By turning a hem in this manner it makes a flatter hem for thick material and helps the pleats to set beautifully. For coarse serges which are more

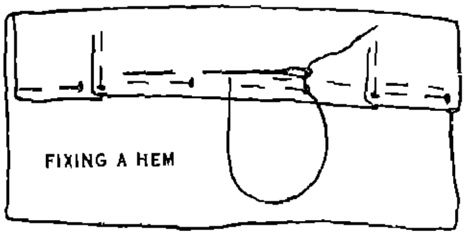


FIG. 2

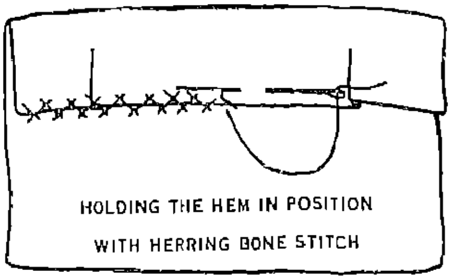


FIG. 3

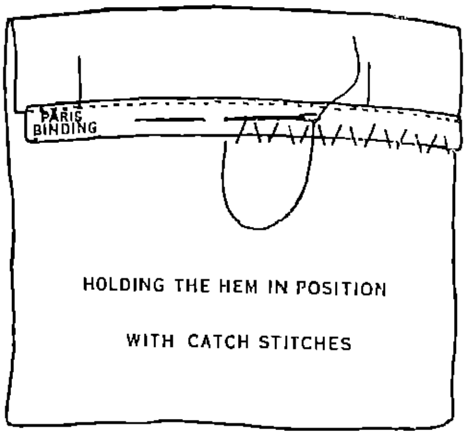


FIG. 4

likely to fray, the raw edge of the hem should be bound with a crossway strip of lining, or covered with paris binding. If the latter is used one edge must first be machined over the raw edge through the single material. In both these cases the hem is catch-stitched down to single threads of the material, Fig. 4. Face the armhole edges of the tunic with a crossway strip. Mark with a pin the length to be set plainly in the front yoke, and form six pleats with the remainder of the material, arranging them to form three box pleats as in Fig. 5. Tack the pleats in position. Arrange the back portion of the tunic in the same way. Set the pleated tunic in the front and back yokes, machining them in position close to the edge of the yoke. Machine together the armhole edges of the yoke. Work another row of machine stitching on all the edges of the yoke $\frac{1}{4}$ in. away from the first line, Fig. 6. *Press the tunic on* the wrong side of the material, pressing the pleats well, and remove all the tacking threads. Place slots on the side seams. A belt to pass through the slots can be made from the same material as the tunic and fastened with a button, or made from a length of woollen braid knotted at the ends. Fig. 6 shows the completed tunic.

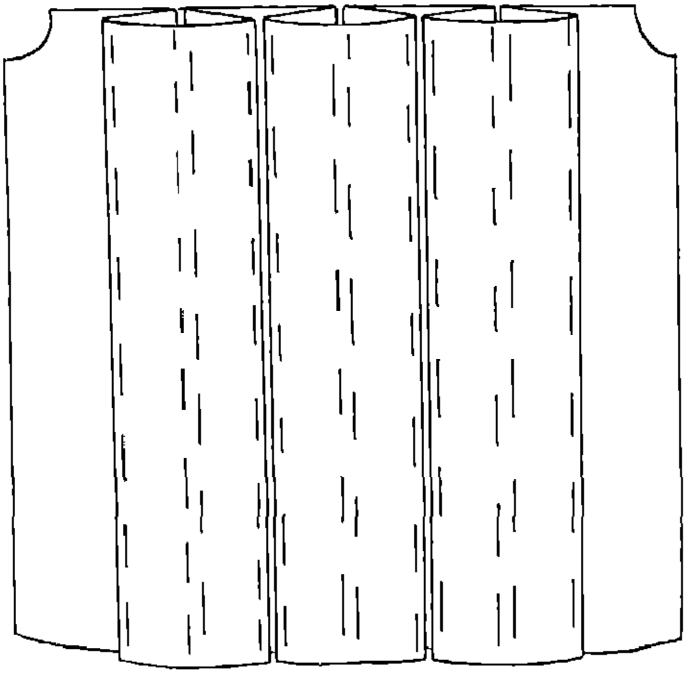


FIG. 5

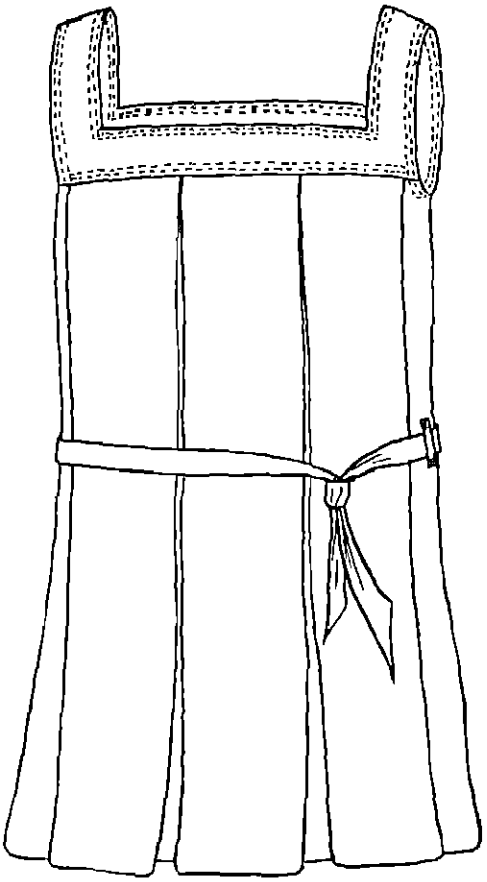


FIG. 6

V. REPAIR WORK

Aim of lesson.—To teach the pupils how to make patches in difficult positions.

Arrangement of lesson.—The pupils will practise the principles first on pieces of material, as the teacher demonstrates. These will afterwards be mounted in their note-books. Actual garments will be repaired later.

Teacher's requirements.—Large pieces of material suitable for demonstrating the various kinds of patch; garments which have already been repaired in the manner to be demonstrated; charts showing the different stages in the various forms of patching; coloured wools; needle; pins; scissors; thimble; easel; drawing pins.

Children's requirements.—Pieces of material which require patching and which are suitable for teaching these new methods of patching; smaller pieces of material from which to cut the patches; needle; cotton; thimble; pins; scissors.

DEMONSTRATION

When a hole occurs near a seam or hem, or in a gathered portion of a garment, it is necessary to unpick the sewing for a distance to enable the patch to be fixed well and more easily.

1. Unpick the sewing for a short distance beyond the hole and the worn part—just enough to allow freedom of handling.

2. Cut the patch large enough, allowing for turnings of the seam or hem. Place it carefully in position on the wrong side of the garment, noting the selvedge threads, and tack it firmly before hemming it in position, Fig. 1.

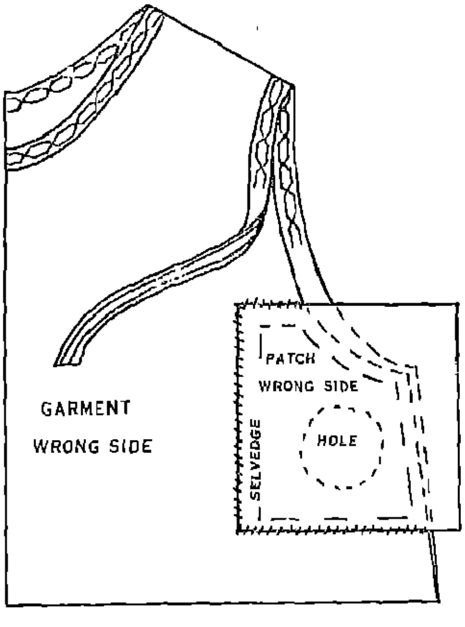


FIG. 1

3. Shape the patch to match the seam or hem of the garment, using the worn part as a guide, thus leaving the necessary turnings.

4. Cut away the worn part, and sew the patch on the right side of the material.

5. Sew up the seam, hem, or gathers, as originally fixed, Figs. 2 and 3.

6. In some cases two patches are necessary, as, for instance, when a garment wears at the under-arm seam. These two patches need not be exactly alike in shape or size, but both must be shaped straight to a thread of the garment. If they can be so arranged it looks neater if they both cross the seam at the same point, Fig. 4.

7. For a tear which occurs at the base of an opening, or where a pocket is joined to a garment, partially unpick the sewing as previously described before the patching is carried out. To prevent a second tear occurring at the same point, make the opening a little longer by attaching an extra piece of material to the false piece, so that the garment may be put on or removed more easily. The join may be hidden by decorative stitchery if desired, Fig. 5. Change the position of the pocket slightly so that the corner lies on the double material of the patch, Fig. 6.

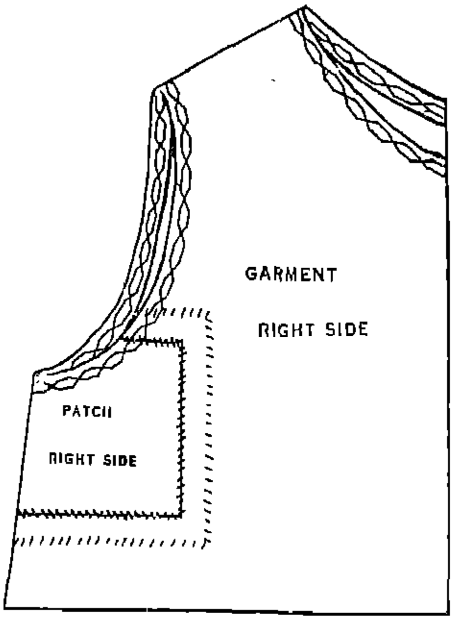


FIG. 2

SECOND YEAR COURSE—FIRST TERM

Pattern making.—Sleeve; collars.

Garment or article to be made.—Pyjama suit completed; duchesse set begun.

Knitting.—Jumper begun.

Processes.—Setting in the sleeve; setting on the collar.

Decorative stitchery.—Petal stitch; cretan stitch; wheat ear stitch.

Repair work.—Darning a thin place; darning a hole in damask.

Discussion of work.—During this discussion two completed pyjama suits should be shown to illustrate two different styles; i.e., one having a jumper and the other a coat. All the differences between the two styles must be noted; e.g., the extra material needed for the fastening of the coat; the collars and their method of setting on; the styles of sleeve; and the general finish of the garments.

A completed decorative article should be shown, such as a duchesse set or luncheon set, which illustrates the stitches to be taught during the year, or the further application of stitches already taught.

Jumpers provide ample scope for the pupils to extend their knowledge of knitting. The printed leaflets offer a wide variety of designs to suit all tastes. One or two completed jumpers should be exhibited.

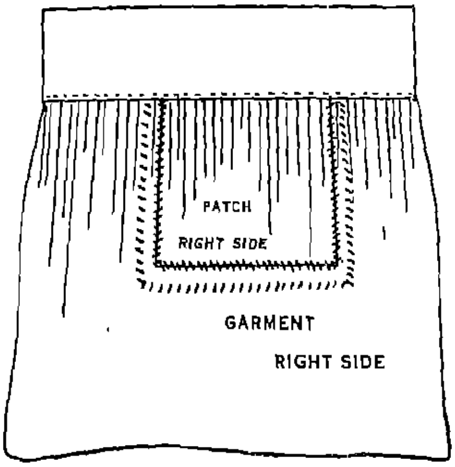


FIG. 3

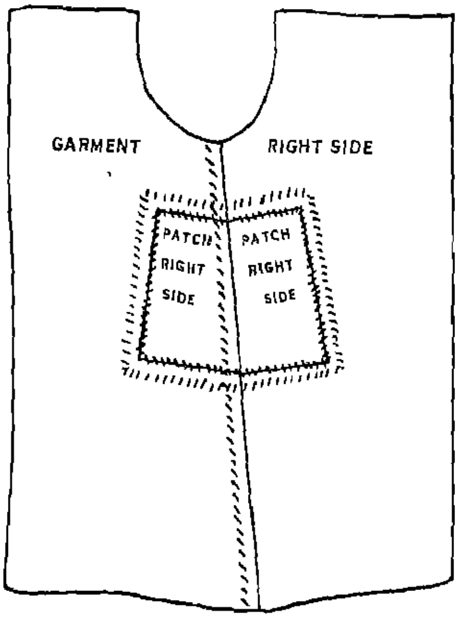


FIG. 4

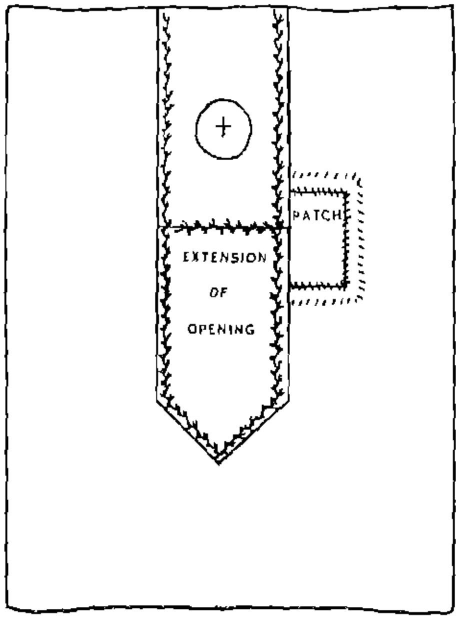


FIG. 5

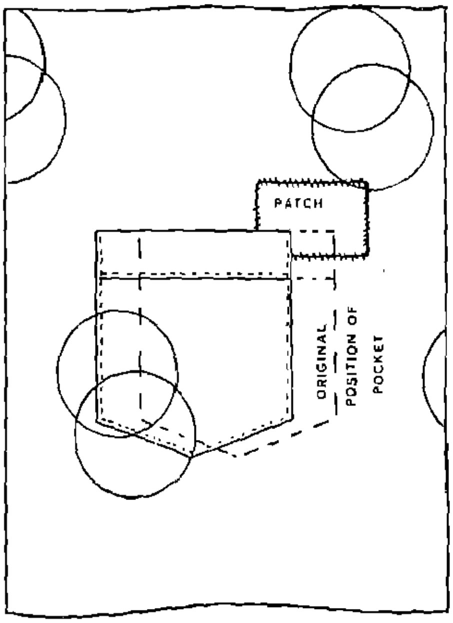
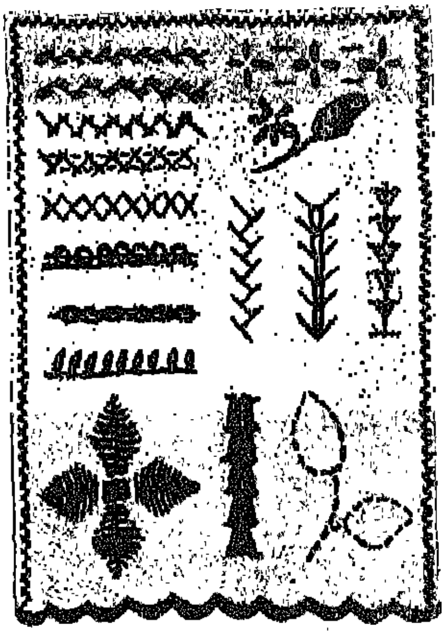


FIG 6



SAMPLER SHOWING DECORATIVE STITCHERY

For the repair work, attention must be drawn to (1) table cloths or napkins which have been suitably darned; (2) an article which shows the method of repairing a hedge tear and cross-cut; and (3) the repairing of a long tear with machining in any coarse household linen, such as a sheet.

After the discussion of the term's work, the new pattern to be drafted may be considered; i.e., the sleeve. The simplest form of sleeve is the plain sleeve with one seam. This may be drafted (1) for the seam to lie in the armpit, or (2) for the seam to meet the under-arm seam of the bodice. The approximate shape of the sleeve may be determined by demonstrating to the pupils with an oblong piece of paper pinned in the form of a cylinder and slipped over the arm. They will readily realise that a portion must be cut away from under the arm in order that the paper may reach the top of the shoulder with ease. In this way a rough outline of the shape of the sleeve may be

I. DRAFTING THE SLEEVE PATTERN

Arrangement of lesson.—The teacher will demonstrate the drafting of the pattern on a large piece of paper pinned to the blackboard, the pupils working with her step by step.

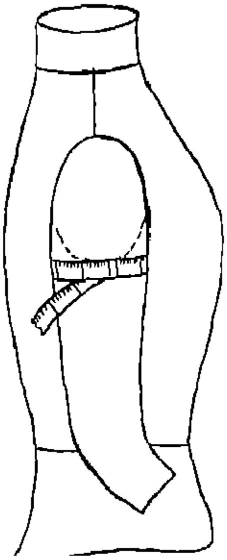
Teacher's requirements.—A large sheet of drafting paper; coloured pencils; two blackboards, on one the drafts of the two patterns are illustrated in different coloured chalks, and on the other the sheet of drafting paper must be pinned; glass-headed pins; ruler; scissors; a drafted pattern of both styles of sleeve; tape measure; a finished garment showing the two styles of sleeve.

Children's requirements.—Sheet of drafting paper; pencil; ruler; pins; tape measure; scissors; notebook.

DEMONSTRATION

Measurements required.—

Arm width.—This is measured round the thickest part of the arm, with the tape measure under the armpit, and taken straight round, Fig. 1.



Inner arm length.—This is measured from the armpit to the wrist with the tape measure inside the bend of the arm, Fig. 2.

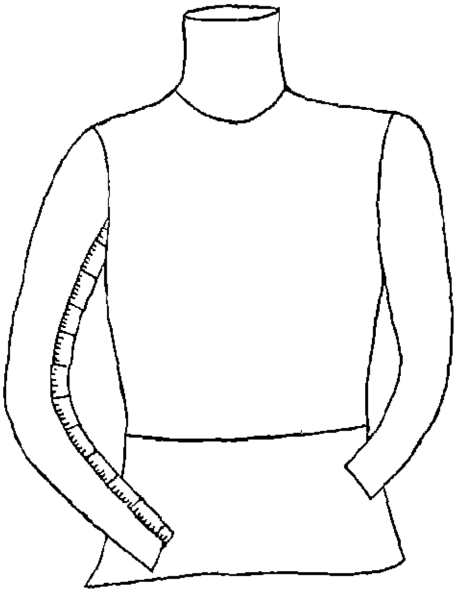


FIG. 2

The teacher must first demonstrate the positions of the tape measure for these measurements, afterwards allowing the girls to measure each other, and then confirm their measurements.

Drafting the pattern.—

Style 1—Seam in armpit.—

1. Draw a line AB = the arm width plus 1½ in. (extra allowance for freedom of movement).

2. From B draw BC at right angles to AB, so that BC = ⅓ arm width plus 1 in.

3. Extend BC so that CD = inner arm length. Complete the oblong ABDE.

4. Draw CF parallel to AB.

5. G = ½AB; H = ½ED; join GH.

6. Join GF and GC with dotted lines. J = ½FG; K = ½CG; JL = 1½ *in.*; CM = 1½ in.

7. Draw in the curve for the top of the sleeve as shown in Fig. 3.

8. DN = EO = 1½ in. (This allows for gathers at the wrist.) Join CN and FO with slightly curved lines, Fig. 3.

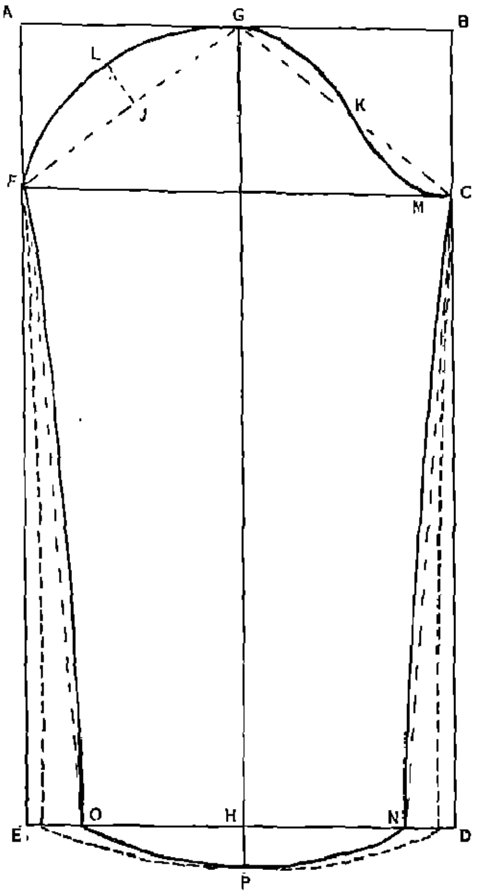


FIG. 3

9. HP = 1½ in. Draw the curved line OPN for the bottom of the sleeve.

The convex curve on one side of the centre line GH represents the upper portion of the sleeve which covers the shoulder joint. The concave curve on the other side of GH represents the under part of the sleeve which lies under the armpit. The dotted line shows the sleeve widened at the wrist for use when a frill is required.

Style 2—Seam to seam.—

1. Draw in the construction lines as for the sleeve, Style 1, with the exception of the curve for the top of the sleeve.

2. FQ = CR = $\frac{3}{4}$ in.; FS = $\frac{1}{3}$FG; CT = $\frac{1}{3}$CG; GY = $\frac{1}{2}$SG; XY = $1\frac{1}{8}$ in.; GM = $\frac{1}{2}$GT; MZ = $\frac{3}{4}$ in.

3. Draw in the curve as shown in Fig. 4. Cut out both patterns on the pattern lines.

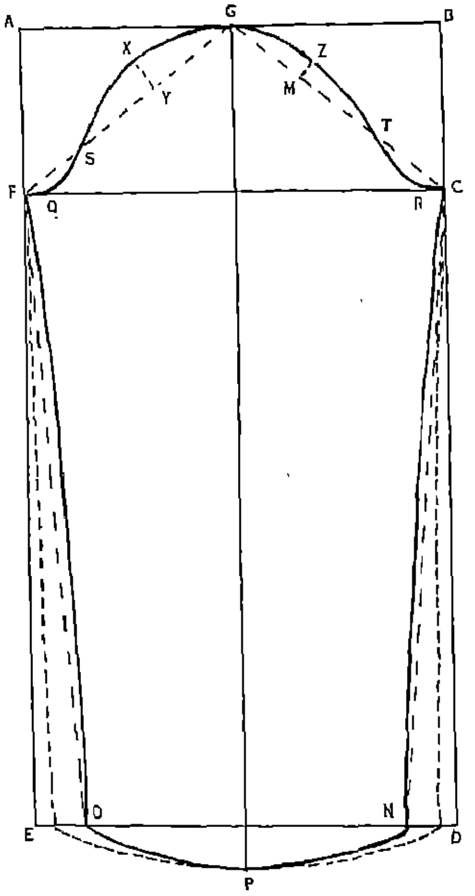


FIG. 4

II. SETTING IN THE SLEEVE

Aim of lesson.—To teach the pupils (1) how to determine the correct sleeve for the right and left arms, and (2) the method of setting in a sleeve to give the correct "hang."

Arrangement of lesson.—The pupils will carry out the teacher's directions as she demonstrates, using their own garment.

Teacher's requirements.—A completed jumper or coat made from the bodice pattern; hessian to represent a second jumper or coat without sleeves; two sleeves having the seam joined and the bottom edge neatened; pins; scissors; thimble; pencil; tape measure; needle; wool; an illustration of the setting in of a sleeve drawn on the blackboard or on a chart.

Children's requirements.—Pyjama jumper or coat without sleeves; two sleeves prepared for setting in; pins; scissors; pencil; tape measure; needle; sewing cotton; thimble; notebook.

DEMONSTRATION

1. Prepare the armhole by hollowing out if necessary. The under-arm part of the garment must fit up to the armpit. The shoulder line may be tested by placing a tape measure under the armpit and holding it vertically at the back of the body. The shoulder seam must project $\frac{1}{2}$ in. beyond the tape, Fig. 1.

2. Test the width of the sleeve before fitting in the armhole by measuring round the armhole and also along the top curve

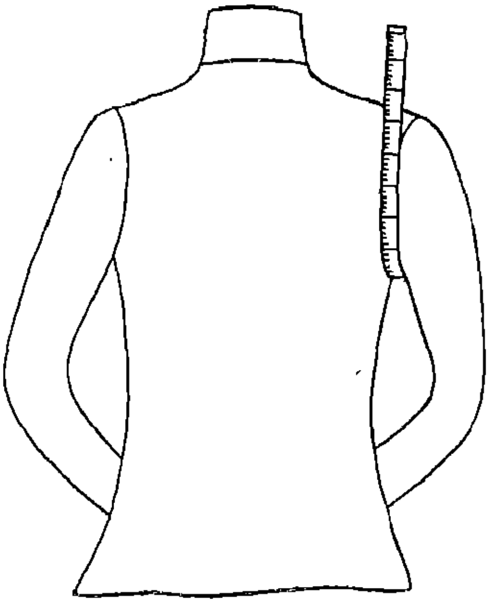


FIG. 1

of the sleeve and comparing the lengths. If the latter is 1 in. longer, then the sleeve is ready for setting in; if it is more than 1 in., then the sleeve must be made narrower or the armhole hollowed a little more.

3. Tack-mark the sleeve pitch or inset mark for the sleeve seam which lies 1½ in. nearer the front from the under-arm seam.

4. Determine the correct sleeve for the right and left arms.

(*a*) To determine in which armhole the sleeve has to fit, hold the sleeve at right angles to the body.

(*b*) If the sleeve has been drafted to fit *seam to seam with the under-arm seam*, hold the sleeve seam facing backwards; then the slightly hollowed portion at the sleeve head must fit to the front of the arm, Fig. 2.

(*c*) If the sleeve has to be set with the seam to the front of the under-arm seam, then hold the sleeve with the seam facing forwards. Again the hollowed portion must fit to the front of the arm, Fig. 3.

5. *Holding the sleeve seam from the inside*, place it to the inset mark of the garment with the right side towards the worker, and pin securely.

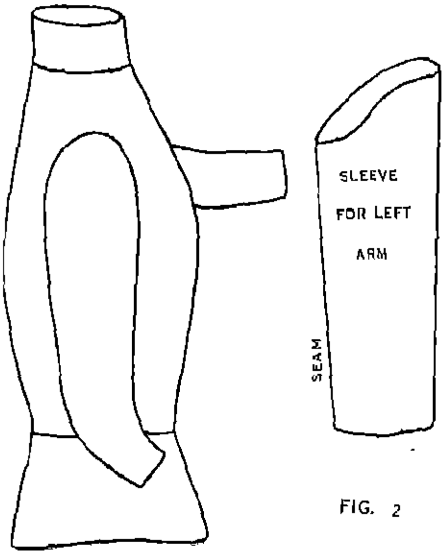


FIG. 2

6. Turn the garment over the sleeve so that the sleeve hangs inside it, and work with the inside of the sleeve towards the worker, Fig. 4.

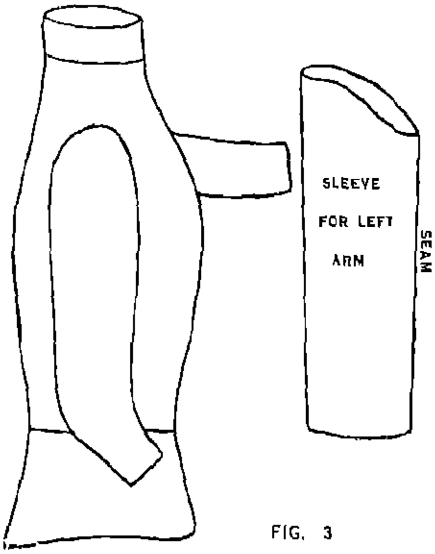


FIG. 3

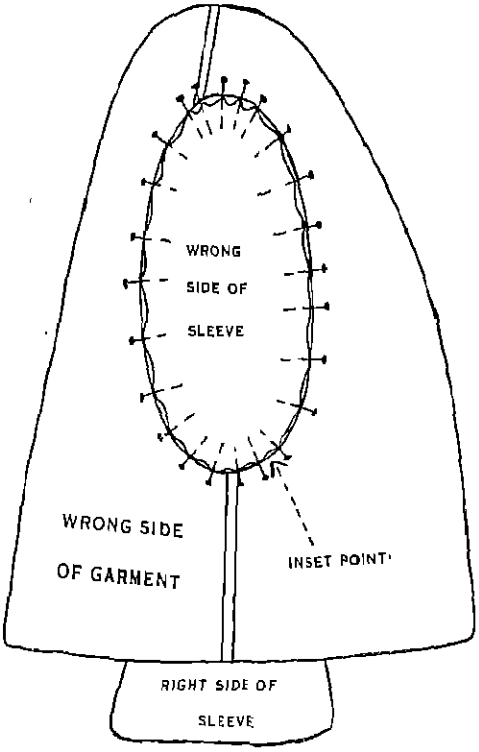


FIG. 4

7. Pin the remainder of the sleeve into the armhole, easing it a little under the arm, fitting it plainly along the back and front, and easing in carefully the remaining fullness over the shoulder, allowing a little more in front of the shoulder seam than behind it. All pins must be inserted from the inside of the sleeve to be under control of the left thumb when easing in the fullness, Fig. 4.

8. Test the "hang" of the sleeve after pinning, and alter if necessary.

9. Tack the sleeve in position with small tacking stitches.

10. Machine the sleeve into the garment, working from the inside of the sleeve.

11. Neaten the raw edges by (*a*) overcasting the two together, or (*b*) binding with a crossway strip.

The sleeve cut in Style 2 pattern is set in the garment in the manner already described, beginning with the seam of the sleeve placed to the seam of the garment.

III. DRAFTING THE COLLAR PATTERN

Arrangement of lesson.—The pupils draft their patterns along with the teacher, following her step by step.

Teacher's requirements.—Patterns of the various styles of collar; completed garments showing a flat collar and an upstanding collar; the method of obtaining the different styles of collar illustrated on one blackboard; a second blackboard on which is pinned a sheet of drafting paper; coloured pencils; scissors; tracing wheel; bodice pattern.

Children's requirements.—Sheet of drafting paper; pencil; scissors; tracing wheel; bodice pattern.

Introduction.—The shapes of collars vary between two extremes—the collar may be cut to stand up at the back of the neck, or it may be cut to lie flat on the shoulders, and between these two extremes many varieties of collar may be cut. The main principle underlying the cutting out of collars is that the straighter the neck line is cut the more the collar tends to stand up, and the rounder the neck line the flatter the collar lies. Any style of collar may be cut from the bodice pattern by placing the shoulders of the back and front portions together in the same manner as when drafting yokes.

DEMONSTRATION

Flat collars.—

1. Place the bodice pattern on a folded sheet of drafting paper with the shoulders together, and the back of the bodice pattern to the fold of the paper if the garment has to be fastened at the front or *vice versa*.

2. Draw on the bodice pattern the style of collar required. Fig. 1 shows three styles of collar.

3. Wheel all round the design with a tracing wheel, and cut out the pattern of the collar from the paper underneath.

4. If desired, the neck line of the garment may be altered from the usual round shape to form a V-shape at the front. Fig. 2 shows two collars drafted to suit the altered neck line.

Upstanding collars.—This style of collar is usually to be found on a tailored garment; e.g., shirt blouse, and is made in conjunction with revers. Instead of making a front opening in the usual way, a facing of material is joined to the front edges of the blouse.

Carrying out the principle of cutting collars, begin by drawing a straight line AB, or a slightly curved line (depending on the desired shape) equal in length to the neck edge. Measure the required depth of the collar, and draw to the shape desired, Fig. 3.

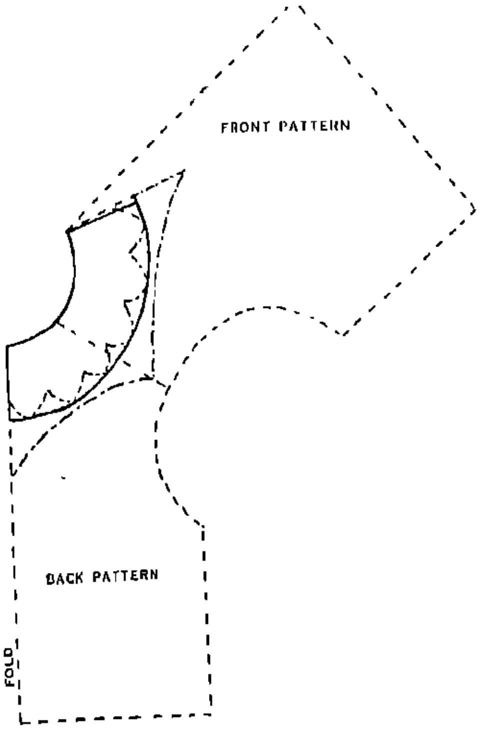


FIG. 1

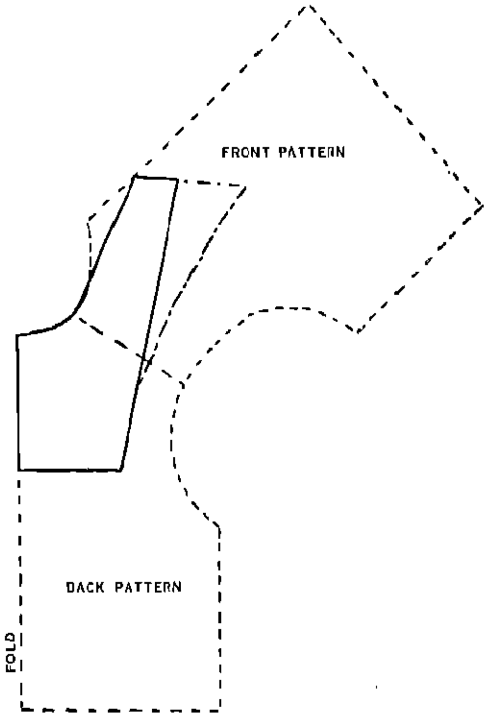


FIG. 2

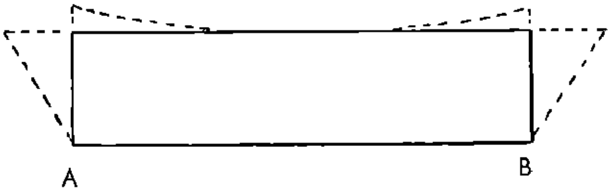


FIG. 3

IV. SETTING ON THE COLLAR

Aim of lesson.—To teach the pupils the correct method of attaching any kind of collar to a garment.

Arrangement of lesson.—The pupils carry out the teacher's instructions on their own garments as she demonstrates each process.

Teacher's requirements.—Two completed garments, one having a flat collar attached and the other an upstanding collar; hessian cut to represent the front and back bodice portions of a garment; a flat collar; an upstanding collar; pieces of material for facings; sketches illustrating the various stages of the lesson on a chart or blackboard; pins; needle; wool; scissors; thimble; crossway strip of material.

Children's requirements.—Their own garment and the collar to be attached; specimen pieces of material to represent a bodice portion on which to attach the alternative kind of collar; pieces of material for facings; pins; needle; sewing cotton; scissors; thimble; *notebook;* crossway strip of material.

DEMONSTRATION

Setting on a flat collar.—

1. Place the collar in position round the *neck line* of the garment with the under side of the collar to the right side of the garment. Tack in position.

2. Place a crossway strip to the edge of the collar and the garment, and machine the three together, Fig. 1.

3. Raise the strip, turn it down to the *wrong side of the garment,* and secure it with hemming stitches, Fig. 1.

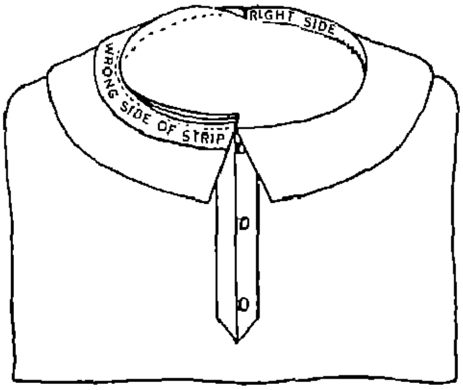


FIG. 1

An upstanding collar.—

1. Using the front bodice pattern cut out a facing *in material* for each side, wide enough to lie along the shoulder line for about 2 in. in order that the rever may fold back, and about 2 in. longer than the opening, Fig. 2. If possible the free edge of the facing should be selvedge to avoid hems which may show through the blouse when pressed. If this is *not* possible, then the facing may be narrowed towards the base of the opening as shown by the dotted line, Fig. 2.

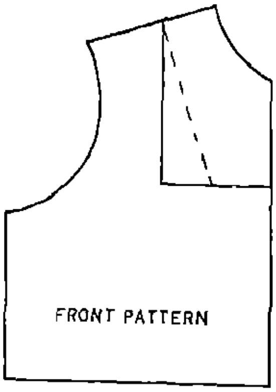


FIG. 2

2. Lay the right sides of the facings to *the right side of the material* edge to edge as in Figs. 3A and 4A. Run-stitch the edges of the opening only if the collar is to be joined to the end of the revers, Figs. 3A and 3B. If the collar is not to be stitched all the way, then stitch the facing to the garment along the neck line as well as down the front so that the revers are completed when turned to the right side, Figs. 4A and 4B.

3. Turn the facings and neaten the raw edges by (*a*) turning a narrow fold on the wrong side and securing it with small running stitches; or (*b*) overcasting.

4. Machine the two pieces of the collar together on all edges except *the neck edge;*

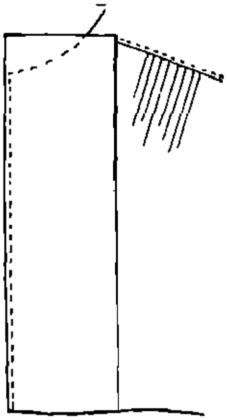


FIG. 3 A

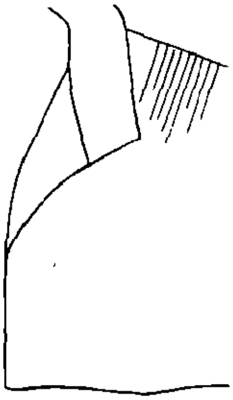


FIG. 3 B

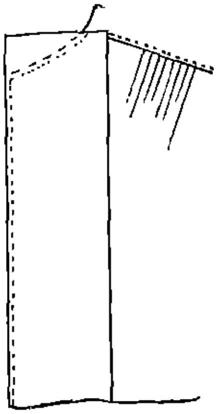


FIG. 4 A

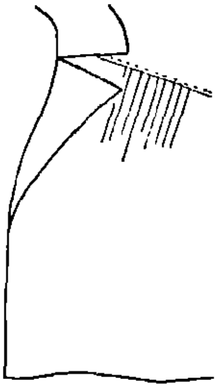


FIG. 4 B

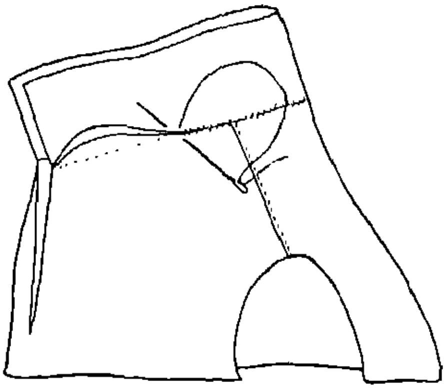


FIG 6

turn right side out and tack along the joined edges.

5. Stitch one edge of the collar on the neck edge of the blouse on the right side. Turn in the remaining edge of the collar and hem it to the back of the neck, slip-stitching across the facings, Fig. 5.

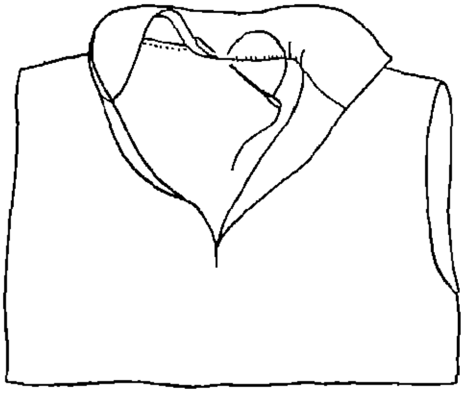


FIG. 5

6. The collar may also be attached by *first stitching one edge along the neck edge* of the blouse on the wrong side and felling the second edge of the collar along the turnings on the under side of the collar, Fig. 6.

BRIEF INSTRUCTIONS FOR THE CONTINUATION OF THE PYJAMA SUIT

Measurements required.—Hip measurement; side length from waist to ankle.

Obtaining the pattern.—Alter the bodice *as in Figs. 1A and 1B, to allow the jumper* or coat to fit with ease over the hips. Find the difference between half the bust measure plus 1 in. (AB + CB) and half the hip

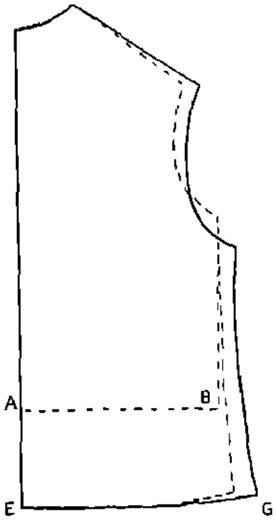


FIG. 1 A

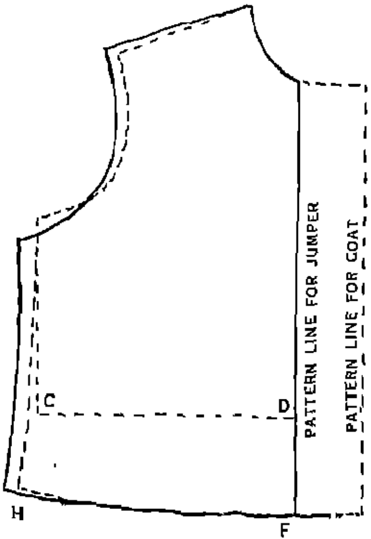


FIG. 1 B

measure plus 1 in. EG = AB plus half the difference. FH = DC plus half the difference. Widen the shoulder line ½ in. Lower the armhole 1 in. and widen ½ in. Extend the front for the coat. Alter to required length.

Widen the sleeve pattern 1 in. on each side to correspond, Fig. 2.

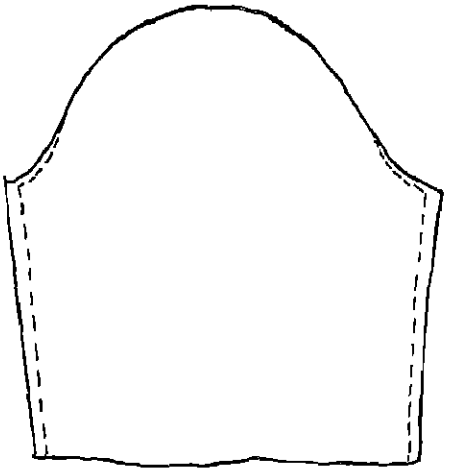


FIG. 2

Using the knicker pattern, make the alterations as in Fig. 3.

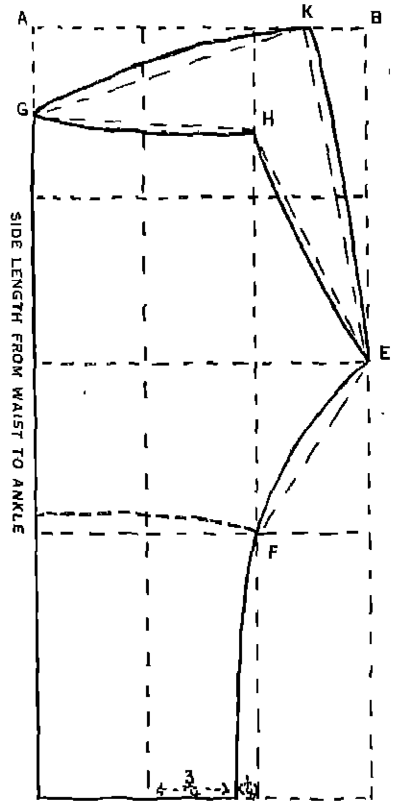


FIG. 3

Computation of cost.—Kinds of material; widths; prices per yard; quantity required.

Cutting out.—Cut out, allowing ½ in. *turnings and enough for a hem if desired* at the bottom of the leg. Cut out strips for facings or collar and one or two pockets from the shaping of the material.

Making up the suit.—Join the under-arm and sleeve seams with a French seam. Turn up or face the bottom of the sleeves and set them in. Neaten the neck line if round or V-shaped by facing, or by setting on a flat collar. If a coat, face the wrap-over, and set on a collar with revers. Turn up a hem or face the bottom edge. Face the top edge of the pockets and place one in position on the left breast, or one at each side of the centre front along the bottom, Figs. 4 and 5. Sew up the leg seams of the trousers, afterwards sewing the body seams. Face or turn hems along the bottom of the legs. Face the waistline and insert elastic.

V. DECORATIVE STITCHERY

Aim of lesson.—To extend the pupils' knowledge of stitchery for the ornamentation of household articles.

Arrangement of lesson.—As the teacher demonstrates the working of each new stitch the pupils will work with her step by step.

Teacher's requirements.—A piece of crash; coloured wools; needle; scissors; thimble; duchesse sets showing the application of the new stitches and others which have already been learnt; blackboard or chart containing sketches of the various stages in the working of each stitch; easel; drawing pins.

Children's requirements.—A piece of crash to be used as a sampler; embroidery cottons; needle; scissors; thimble; pencil; notebook.

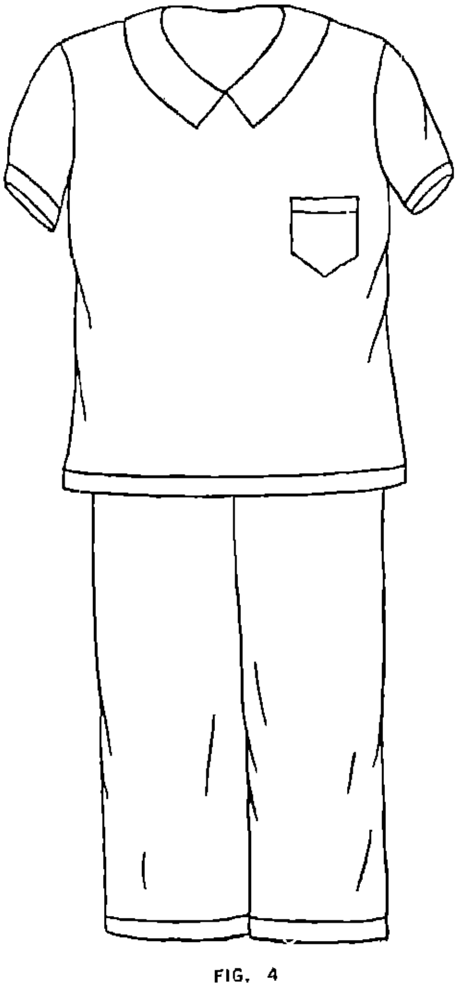


FIG. 4

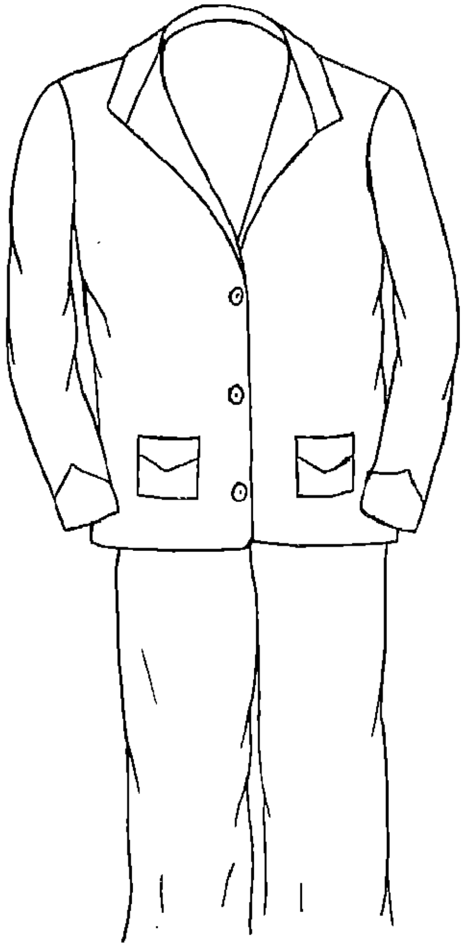


FIG. 5

DEMONSTRATION

Petal stitch.—This stitch lends itself to the decoration of curved lines, and has a most effective appearance when finished.

1. Draw a faint pencil line on the crash.

2. Begin at the left end of the line by bringing the needle through the material ¼ in. along the line.

3. Insert the needle at the starting point and bring it through exactly half way between the two, Fig. 1.

4. Make a chain loop at an angle to the line, Fig. 2.

5. Fix the chain loop down with a small stitch as in lazy daisy stitch, and pass the needle through on the traced line ready to begin the next stitch, Fig. 3.

Cretan stitch.—This stitch is useful for fillings, being easily adaptable to spaces of varying widths.

1. On the crash trace a design such as the one in Fig. 4.

2. Begin by bringing the needle through the material at the apex of one of the points in the design from the wrong side to the right side.

3. Place the needle through the right-hand traced line close to where the wool first came out, and bring it out again just a little below and nearer the centre of the leaf, passing it over the working wool, Fig. 4.

4. Repeat the process on the opposite side and continue filling in the space, working alternately from one traced line to the other, Fig. 4.

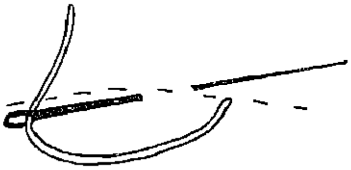


FIG. 1

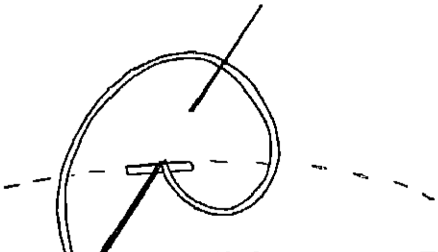


FIG. 2

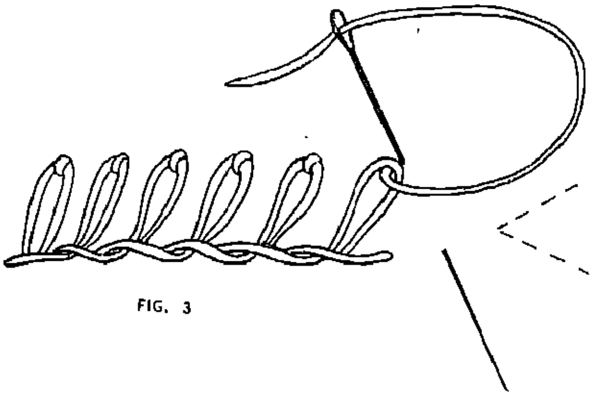


FIG. 3

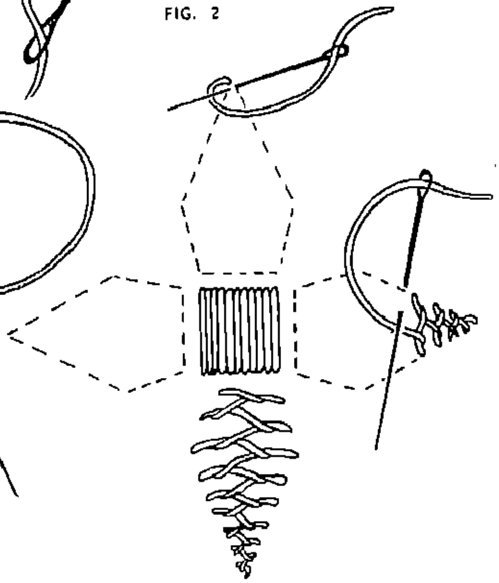


FIG. 4

5. Fig. 5 shows a variation of cretan stitch which forms a closer filling. The simple cretan stitch is so worked that the plaited portion in the centre pulls the side stitches into a Vandyke shape.

Wheat ear stitch.—This stitch makes an ideal border stitch.

1. Work two slanting tacking stitches at an angle to each other.
2. Bring the needle out a little further along from where the tacking stitches meet, Fig. 6A.
3. Pass the needle under the tacking stitches without picking up any material, Fig. 6A.
4. Pass the needle through the material at the point where it first came out. This forms a chain stitch and completes the first stitch, Fig. 6B.
5. Repeat the process to continue working the stitch, Fig. 6C.

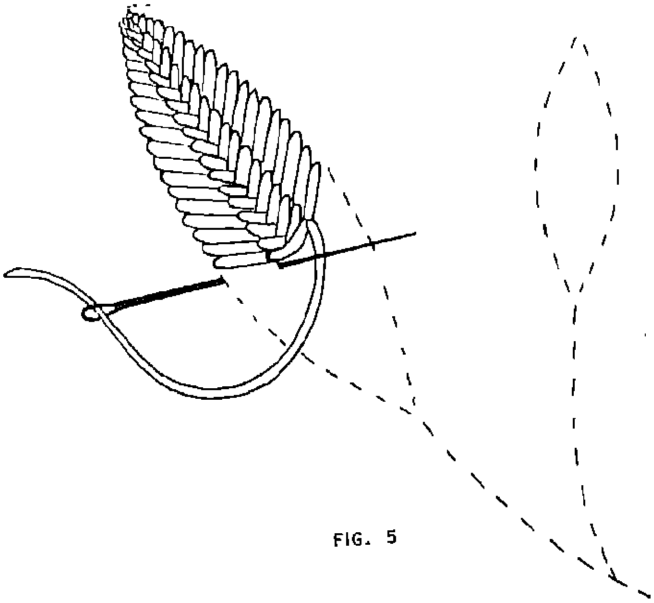


FIG. 5

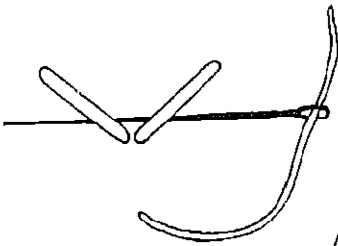


FIG. 6 A

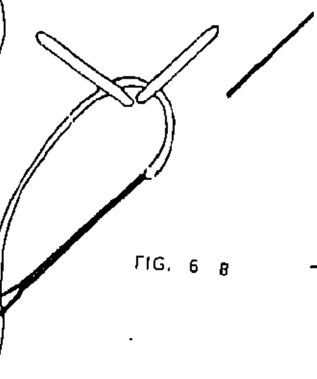


FIG. 6 B

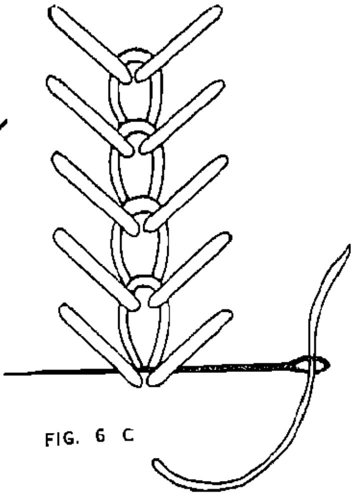


FIG. 6 C

BRIEF INSTRUCTIONS FOR THE MAKING OF THE VARIOUS STYLES OF DUCHESSE SET

In Fig. 1 the set consists of two oblong and two square mats cut from half a yard of 36 in. wide material. Form hems on all edges of the mats, and hold these in position with wheat ear stitch. Trace a design such as is shown in the figure, and fill in the leaves with cretan stitch, using satin stitch for the centre.

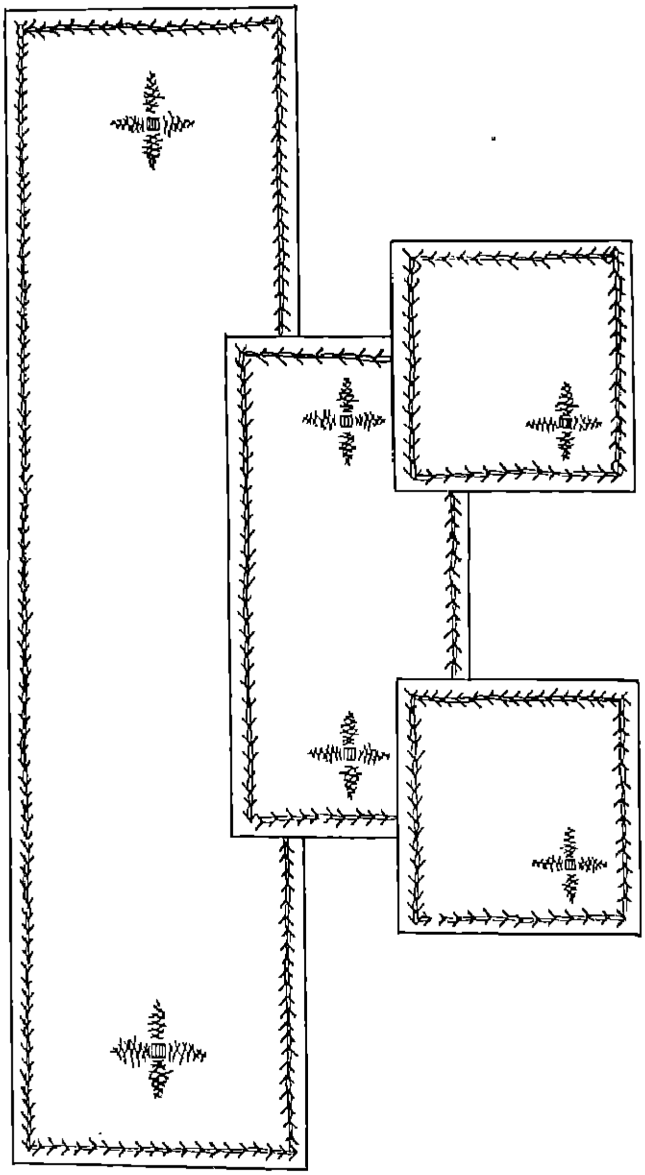


FIG. 1

Fig. 2 shows a set which consists of one large circular mat and four small circular mats. Work the traced circular line with a line of running stitches, afterwards covering them closely with blanket stitches. Work blanket-stitched loops round the outside edges of all the mats, working them in groups of six as shown in Figs. 3A, 3B, and 3C. At a suitable distance from the outside edge of each mat construct a concentric circle and work petal stitch along the traced line.

The decorative stitchery may be applied in a similar manner to a set consisting of one large oval mat and two medium sized circular mats.

Those members of the class who work more quickly than the average may like to complete their work by the end of this term, since a duchesse set is a useful present to give at Christmas.

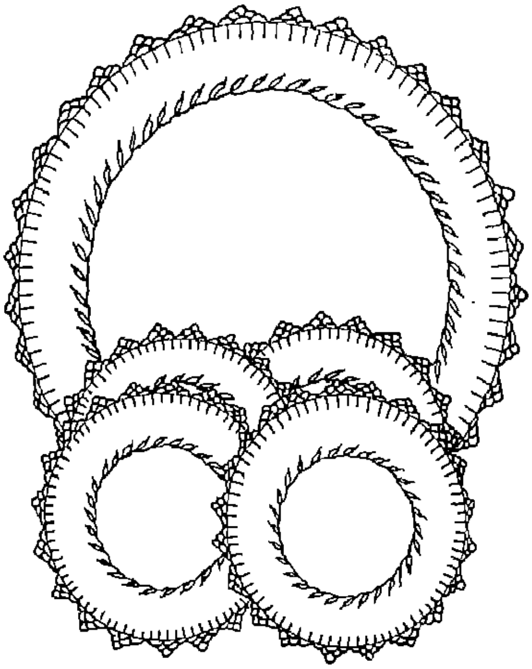


FIG. 2

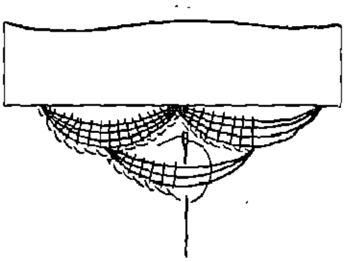


FIG. 3 A

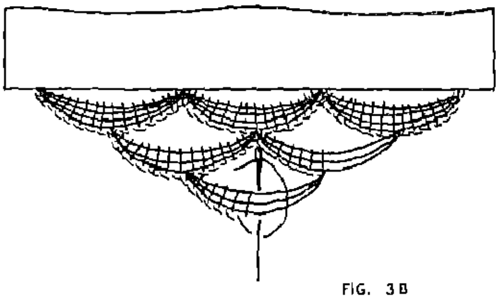


FIG. 3 B

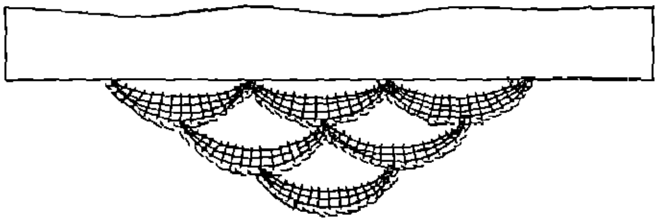


FIG. 3 C

VI. REPAIR WORK—DARNING TEXTILES

Aim of lesson.—To teach the pupils how to prolong the life of household garments.

Arrangement of lesson.—While the teacher demonstrates the pupils will practise the principles on a piece of material which will afterwards be mounted in their notebooks as a sampler.

Teacher's requirements.—Large pieces of material suitable for demonstrating the different darns; articles which have already been repaired; charts with illustrative sketches; easel; drawing pins; coloured wools; needle; scissors; pins; thimble.

Children's requirements.—Pieces of material which require darning; needle; cotton; pins; scissors; thimble.

Introduction.—All darning is worked on the wrong side of the material except on lined garments. When darning on the wrong side, always leave loops to allow for shrinkage—from $\frac{1}{16}$ to $\frac{1}{8}$ in. is quite sufficient. If darning on the right side, loops must not be left, but care must be taken that the threads do not cause the material to pucker. When crossing a tear always keep the thumb and forefinger of the left hand on the raw edges while darning the thread through to avoid fraying. After darning press with a hot iron on the wrong side of the material.

Materials to use.—For linen, use fine flourishing thread or flax thread with a fine straw needle. For woollen materials use suitable wools, but if any difficulty arises in matching the colours, selvedge ravellings of the material may be used.

DEMONSTRATION

Darning a thin place.—Darn all over and around the thin place, selvedge way or the way of the strain, Fig. 1.

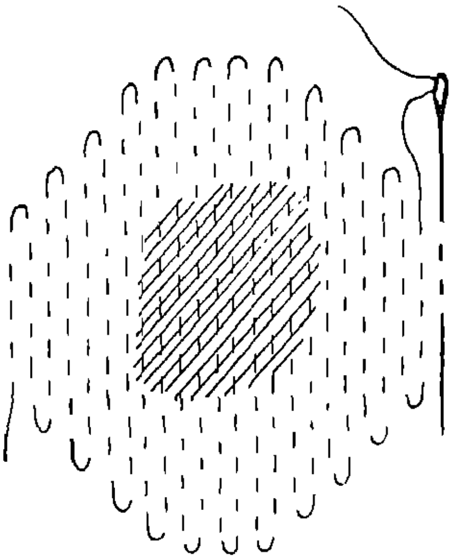


FIG. 1

Darning a hole in fine material (damask).—

1. For a small hole work single darning all round the hole to strengthen the worn part of the material, then darn in the opposite direction, thus weaving a new piece of material into the hole, Fig. 2.

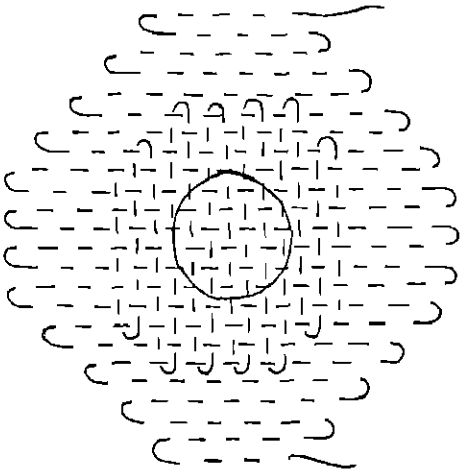


FIG. 2

2. For a large hole a patch must be darned in.

(*a*) Cut a patch about ¾ in. larger than the hole, selvedge and weft way.
(*b*) Place the right side of the patch to the wrong side of the material and tack carefully in position, tacking down the edges on the wrong and right sides.
(*c*) Darn on the right side (selvedge sides first) across the overlapping edges, continuing with the darning stitches for ⅛ in. on both the patch and the material, Fig. 3.

When they have mastered the principles and attained a standard of proficiency, the pupils must carry out these darns on any household article from their home.

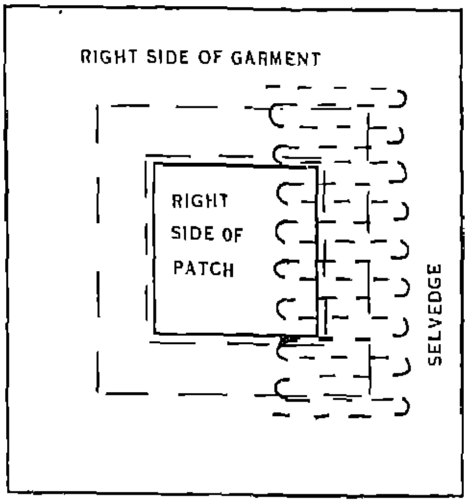


Fig. 3

SECOND YEAR COURSE—SECOND TERM

Pattern making.—Cuff.

Garment or article to be made.—Gym blouse; duchesse set continued; luncheon set begun.

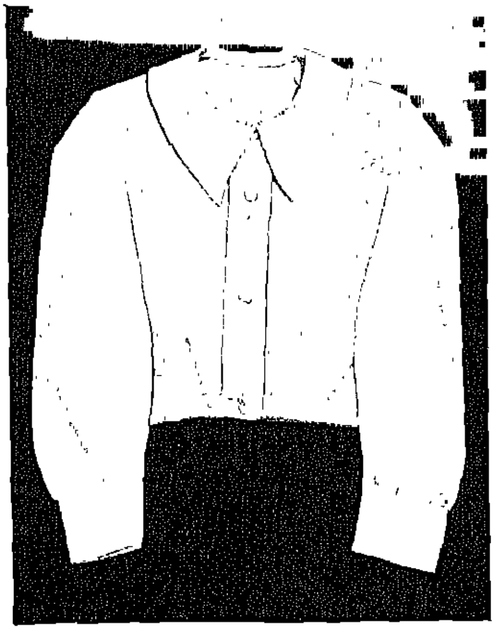
Knitting.—Jumper continued.

Processes.—Wrist openings; setting on a cuff; fastenings; tucking.

Decorative stitchery.—Raised chain stitch; Portuguese border and chain stitch; long-and-short stitch.

Repair work.—Darning textiles continued.

Discussion of work.—A gym blouse should be exhibited and its chief features noted. Reference must be made to the principles learnt during the first term, such as setting on the collar and setting in the sleeve. Attention must be drawn to the new method of neatening the bottom of the sleeve; viz.,



Gym Blouse

by means of a cuff, and the different processes involved by the use of this method, such as wrist openings and fastenings. Garments having different kinds of fastenings should be on view for reference purposes.

The completed duchesse sets should be in evidence once more, along with two different styles of luncheon set. Keen embroidery workers will be eager to begin a second decorative article which may be completed at home if time does not permit at school.

Any difficult stitch which may arise in the knitting of the jumper should be dealt with. It is advisable to make a comparison between the teacher's completed jumper and the pupils' knitting, both in regard to the progress made and the quality of the work. The girls must then be encouraged to work quickly and attain a certain standard of perfection at the same time.

For the repair work, it would be as well for the teacher to have with her certain articles which have already been repaired, illustrating the methods to be dealt with during the term.

After the discussion of the work the salient features of the pattern to be drafted may be considered, as, for instance, the measurements required in order to draft the cuff pattern, and the places where the tape measure must fall in order to obtain the correct measurements.

I. DRAFTING THE CUFF PATTERN

Arrangement of lesson.—The pupils will draft their own patterns as the teacher demonstrates on the blackboard.

Teacher's requirements.—A sheet of drafting paper; coloured pencils; chart showing how to obtain the cuff measurements; blackboard on which the draft of the cuff is illustrated; blackboard to be used for demonstrating the draft; a drafted pattern; a gym blouse; drawing pins; scissors; tape measure; ruler.

Children's requirements.—A sheet of drafting paper; pencil; ruler; tape measure; scissors; notebook.

DEMONSTRATION

Measurements required.—

1. Round the wrist, taken closely over the wrist bone, Fig. 1.

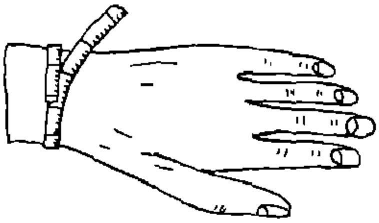


FIG. 1

2. Depth of cuff, according to taste, Fig. 2.

3. Width round the arm at the top of the cuff, Fig. 2.

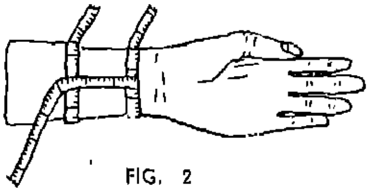


FIG. 2

4. Round the hand, measured round the knuckles with the thumb placed under the palm and the end of the tape lying on the back of the hand, Fig. 3.

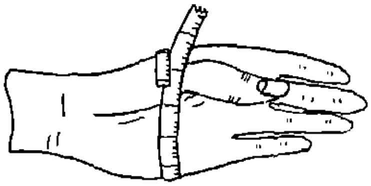


FIG. 3

This is a measurement required when a cuff is being made without fastenings, and so must be large enough to pass over the hand comfortably.

The girls must take each other's measurements, the teacher afterwards confirming them.

The pattern is drafted as for a tightly *fitting cuff*, the bottom line AB being the measurement round the hand and the top line EF being the width round the arm at the top of the cuff.

Drafting the pattern.—

1. Draw a line AB equal to the width round the wrist. C = ½AB.

2. CD equals the width of the cuff (drawn at right angles to AB). DE = DF = ½ width round the arm at the top of the cuff.

3. Join AB and EF with curved lines, curving to ½ in. at the centres H and G respectively, Fig. 4.

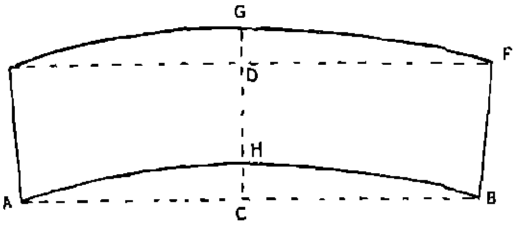


FIG. 4

The top line or one end of the cuff may be shaped according to fancy after the foundation draft has been properly made as in Figs. 5 and 6. Extra allowance must be made for the amount of the required wrap-over. For a very narrow cuff one consisting only of a straight band is satisfactory.

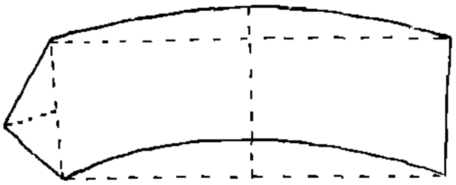


FIG. 5

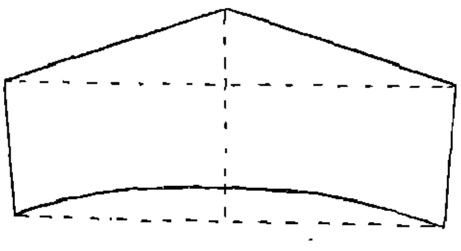


FIG. 6

A cuff is made in double material and if one end is pointed care must be taken to avoid cutting two cuffs for one arm.

II. WRIST OPENINGS

Arrangement of lesson.—As in previous lessons, the pupils will work along with the teacher step by step.

Teacher's requirements.—A piece of material to represent the bottom portion of a sleeve; strips of the same material; coloured wools; needle; scissors; thimble; pins; gym blouse showing the completed wrist openings; sketches on the blackboard.

Children's requirements.—A piece of material to represent the bottom portion of a sleeve; strips of the same material; cotton; needle; scissors; thimble; pins; notebook.

Introduction.—In order that a sleeve with a closely fitting cuff which fastens may be removed quite comfortably over the hand, the opening must extend above the cuff into the lower part of the sleeve itself. To determine how far the opening should extend, the total length of the opening in the cuff and sleeve together should equal the wrist measurement; e.g., if the wrist measurement is 6 in. plus 1 in. for the wrap-over (i.e., 7 in.) and the depth of the cuff is 3 in., then the opening must extend 3 in. in the sleeve. Openings must be neatened in such a way that the back part of the sleeve wraps over the front. The position of the opening may be (1) in the seam of the sleeve or (2) cut in the sleeve.

Neatening the opening.—

1. If the opening is in the seam of the sleeve, care must be taken that it does not gape apart and show the arm, as the opening is rendered conspicuous since it occurs on

the front of the arm. A good method which may be used to prevent this is to neaten the opening with the continuous wrap method taught in the junior school. When carrying out this method, it is necessary to snip across the first turning of the French seam, just on a level with the end of the machining, to allow the wrap to be fixed continuously, Fig. 1. Neaten the raw edges caused by the snipping with buttonholing.

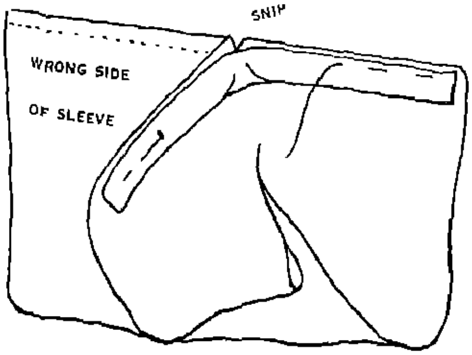


FIG. 1

2. When an opening is cut in the sleeve it is made on the under side of the sleeve one-third of the under side from the seam, Fig. 2. In this position the opening is out of sight both from the back and front when the arm is hanging naturally against the side, and because of this it is the method usually adopted by good workers, especially in the making of shirt blouses. Neaten the opening before the seam of the sleeve is joined by the following method.

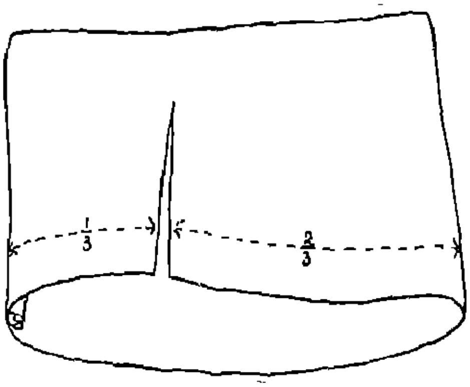


FIG. 2

DEMONSTRATION

1. Cut two false pieces selvedge way, one 2½ in. wide and 1 in. longer than the opening, and the second 1 in. wide and ½ in. longer than the opening.

2. Tack and machine the wide piece to the wider part of the sleeve and the narrow piece to the narrow part, the extra length falling above the slit.

3. Snip the turnings on a level with the end of the slit.

4. Make an extending wrap with the wide piece, machining along the folded edge and the seamed edge afterwards. Make a false hem with the narrow piece, machining the latter along all the edges to keep them firm.

5. Mitre the end of the extra length of the wide piece and cut away the under part, leaving ¼ in. turnings along the mitred sides above the level of the machining along the base of the triangle.

6. Place the wrap over the false hem and machine the triangle through all the thicknesses of material, Fig. 3.

7. Neaten the raw edge at the back with buttonholing or overcasting.

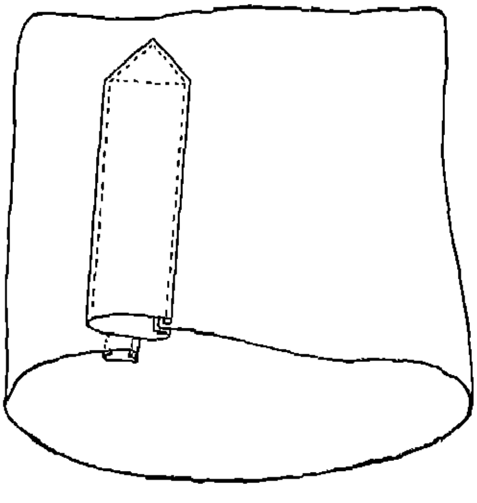


FIG. 3

III. SETTING THE CUFF ON TO A SLEEVE

Arrangement of lesson.—The pupils work along with the teacher as she proceeds with each step.

Teacher's requirements.—The bottom portion of the sleeve used for the neatening of the opening in Lesson II.; a cuff; coloured wool; needle; thimble; scissors; pins; blackboard or chart with illustrations; a gym blouse.

Children's requirements.—The specimen of a neatened wrist opening used in Lesson II.; a cuff; cotton; needle; thimble; scissors; pins; notebook.

DEMONSTRATION

1. Prepare the cuff by *machining together* the two short sides and the bottom edge of the cuff and lining, placing them right side to right side, leaving $\frac{1}{2}$ in. unstitched at the wrist end of the short sides. Turn on the right side and tack along the joined edges.

2. Prepare the bottom edge of the sleeve by inserting a gathering thread all round. Arrange the gathers towards the back of the arm, more gathers lying on the top of the arm than under the arm.

A cuff may be set on the sleeve by one of three methods.

METHOD I

1. Place the cuff inside the sleeve with the lining or under side to the wrong side of the sleeve. Stitch the edges of the lining and sleeve together, taking care that the overlapping side of the opening is folded back if a continuous strip has been used, Fig. 1.

2. Raise the cuff from the inside of the sleeve, allow the turnings to fall inside the cuff. Turn under the turnings of the outside of the cuff and machine over the gathering thread. Machine the remaining edges of the cuff to keep them firm, Fig. 2.

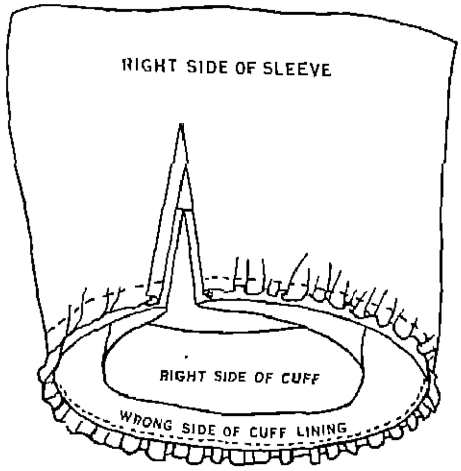


FIG. 1

METHOD 2

This is worked in exactly the opposite way to Method 1.

1. Stitch the outside of the cuff to the outside of the sleeve.

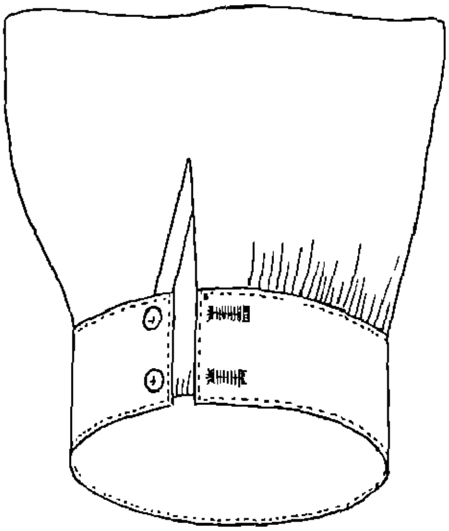


FIG. 2

2. Turn the sleeve inside out and fell the lining of the cuff inside the sleeve, just below the gathering thread, Fig. 3, without letting the stitches show on the right side.

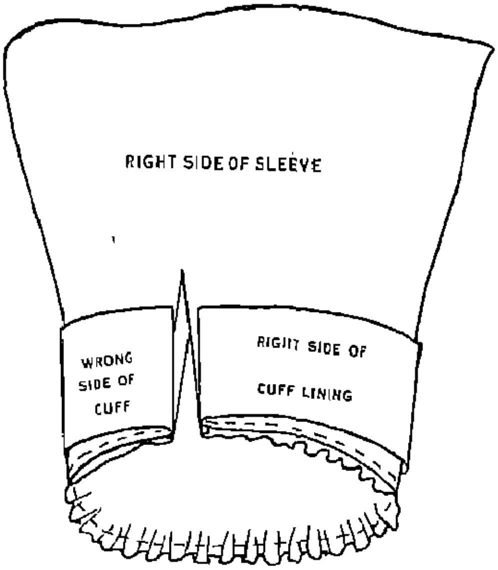


FIG. 3

METHOD 3

Set the gathers into the cuff in the same way as gathers are set in a band in the knicker garment.

IV. FASTENINGS

Aim of lesson.—To teach the correct method of sewing fastenings.

Arrangement of lesson.—As the teacher demonstrates, the pupils practise the principles on their own material.

Teacher's requirements.—Garments which have in use the different kinds of fastening; large hooks and eyes; press studs; the portion of the sleeve used in Lesson III.; coloured wools; needle; scissors; thimble; pins; chart showing the various stages of attaching fasteners.

Children's requirements.—The portion of the sleeve used in the previous lesson; hooks and eyes; press studs; cotton; needle; scissors; thimble; pins; notebook.

Introduction.—Apart from buttons and buttonholes as a means of fastening a garment, there are two other methods; viz., by means of (1) hooks and eyes; and (2) press studs. Hooks and eyes form a strong fastening when there is much strain on a garment, and press studs are more suitable for thin materials and loosely fitting garments.

DEMONSTRATION

To denote the position of the fasteners.—

1. Fold over the wrap of the portion to be fastened; e.g., a cuff, and stab pins through both sides of the opening where the fasteners are required.

2. Raise the wrap slightly and insert pins at the points where the first pin pierces the wrong side of the upper part of the cuff opening and the right side of the lower part of the cuff, Fig. 1.

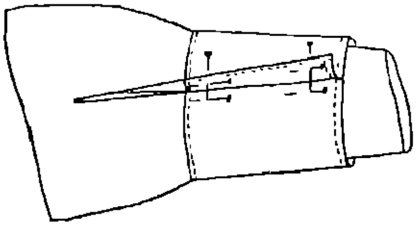


FIG 1

3. The point where the last set of pins enters the material denotes the position of the end of the head of the hook and the end of the eye where the hook is attached, or the centres of each part of the press studs.

To sew on hooks and eyes.—

1. Always use strong cotton.

2. Place the hook in position on the wrong side of the opening and fix it in place

by inserting two or three stitches across the hook between the two rings, Fig. 2A.

3. Buttonhole-stitch round the two rings to the material, Fig. 2B.

4. Pass the needle through the folds of the material and make four or five straight stitches near the bend of the hook to keep the hook firm, Fig. 2B.

5. Pass the needle back again and end off with a few back stitches at the base of the hook. The stitches must not be visible on the right side of the garment.

6. Place the eye in position, and buttonhole-stitch round the two rings, afterwards inserting four or five straight stitches at each side above each ring, and ending with back stitches, Fig. 3.

To sew on press studs.—The knob part of the stud has a flatter base than the socket or cap part, and is therefore usually sewn on the wrong side of the upper part of the opening to give a neater appearance to the finished garment, especially if the garment is made of thin material. The stitches must not be visible on the right side of the garment.

Make a back stitch at the point to be covered by the centre of the stud, place the knob or cap in position, and work four or five overcasting stitches through each hole and the material, Figs. 4A, 4B and 4C. When passing from one hole to the next the needle must be placed in as in Fig. 4A to avoid unsightly strands across the disc.

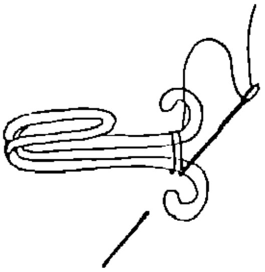


FIG. 2 A

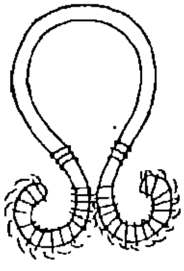


FIG 3

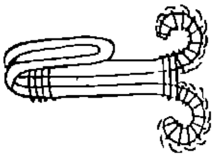


FIG. 2 B

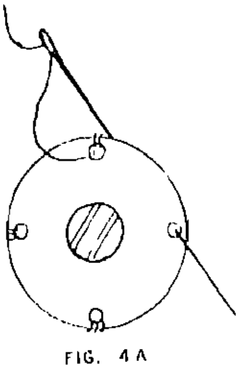


FIG. 4 A

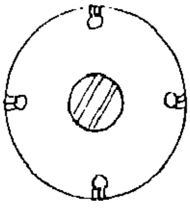


FIG. 4 B

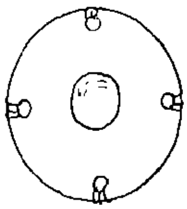


FIG. 4 C

V. TUCKING

Aim of lesson.—To teach the pupils how to dispose of fullness in an ornamental manner.

Arrangement of lesson.—The girls follow the teacher step by step, using a piece of material which will afterwards be placed in their notebooks as a sampler.

Teacher's requirements.—A large piece of hessian; coloured wools; needle; tuck marker; scissors; thimble; blackboard on which are written the rules for good tucking; chart illustrating the chief stages of the lesson;

garments showing tucking; pieces of material showing the different methods of arranging tucks.

Children's requirements.—A piece of material suitable for tucking; tuck marker; needle; cotton; scissors; thimble; pencil; notebook.

Introduction.—Tucking enables a large amount of material to be disposed of, the fullness being compactly arranged to fit into a band or seam. Tucks are really pleats on a small scale which are sewn down along part or the whole of their length according to the purpose for which they are intended. They may be made either (1) selvedge way to reduce the width of a garment; e.g., in a blouse or nightdress where fullness is required over the bust, the fullness may be reduced to fit the yoke or shoulder seam by means of tucks; or (2) weft way to reduce the length of a garment; e.g., in the case of a new garment for a growing child, the garment being made longer than the required length, the length may be reduced by means of tucks. This will admit of the garment being lengthened when required by letting down the amount of material contained in the tuck.

Tucks are often used purely for ornamentation and in such cases may also serve the useful purpose of hiding a join; e.g., (1) when it is necessary to lengthen or widen children's garments by the addition of an extra piece of material; or (2) when it is necessary for a part of a garment to be cut in two smaller sections through shortage of material or narrowness of width. As ornaments, tucks may be arranged in groups (Fig. 1) or evenly spaced (Fig. 2) and may be of the same or of varying widths, Figs. 3 and 4. If a large number is to be made they are very decorative worked in groups of twos or threes.

Points to be remembered to achieve good tucking.—

1. The width of a tuck must be exactly the same through its length.
2. If the tucks are to be all of the same width, they must be exactly equal in size.
3. To ensure good results, always measure and tack the tucks.
4. For the tucks to be effective, the spacing between them must be regular.
5. If the tucks are run by hand the stitches must be even in size and spacing.
6. When the tucks are made by hand they must always be run from the same side; i.e., from underneath, (*a*) so that they will all lie in the same direction when finished, and (*b*) to avoid having to turn the work at every join of thread.
7. If tucks are machined, the tension of the stitch must not be tight or the tuck will have a wrinkled appearance when finished.
8. Machined tucks are usually worked from the upper side.
9. Always press the tucks out flat after finishing the sewing, taking care to avoid making the edge thin and stiff-looking.

Its usefulness in reducing fullness and in shortening the length of a garment for a growing child, combined with its decorative qualities, makes tucking a valuable process which should be practised with care by all who wish to become expert needlewomen. Neglect in the observance of the points enumerated above results in an unsuccessful piece of work, but if these rules are carefully adhered to, the pupils will find that tucking presents little difficulty and the finished article will be a creditable achievement.

DEMONSTRATION

1. As in pleating, calculate the amount of material to be disposed of, and plan out the best arrangement of the tucks. The calculation is made as for pleating; i.e., if 6 in. of material has to be disposed of, then twelve $\frac{1}{4}$ in. tucks may be made.
2. From thin cardboard or very stiff paper prepare a tuck marker in the same manner as a pleat marker, indicating the under surface of the tuck, the part on which it rests, and the space between its fold when

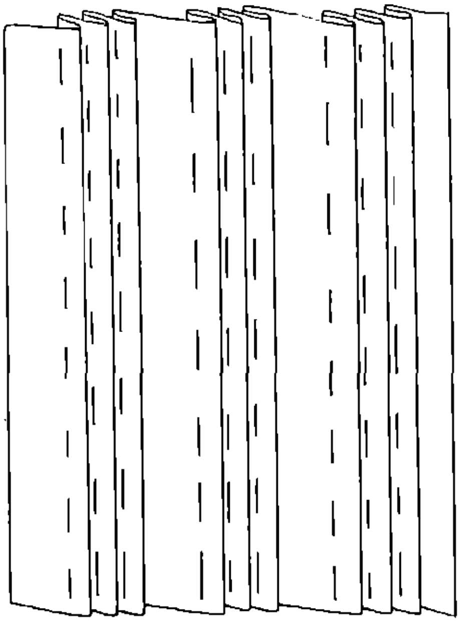


FIG. 1

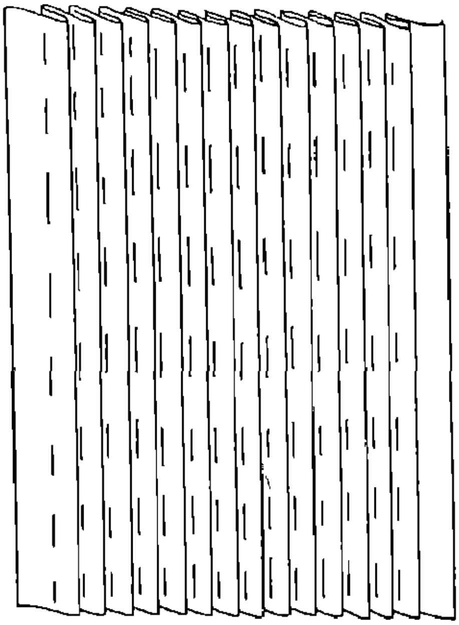


FIG. 2

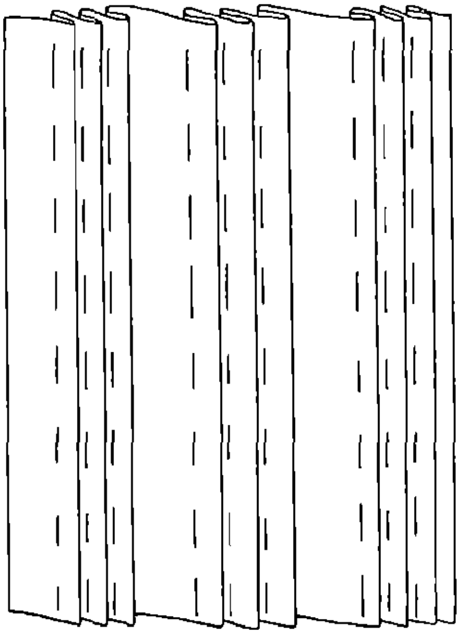


FIG. 3

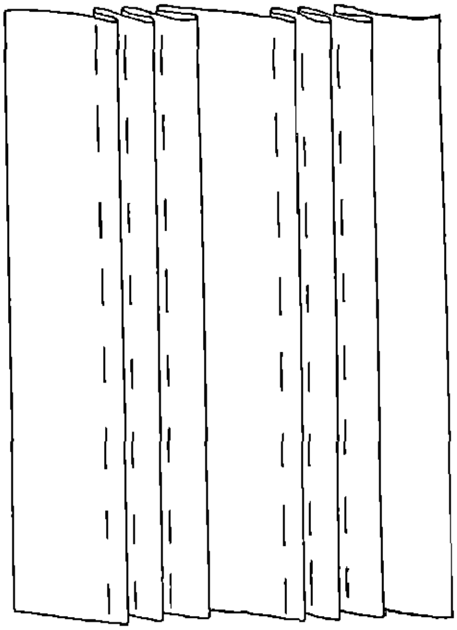


FIG. 4

in position and the stitching of the previous tuck, Fig. 5.

3. Form the first tuck by folding the material along a thread, if in the selvedge direction, measuring from the fold on the under side the width of the tuck required and tacking the tuck on the measured line, *afterwards running* it along the tack-marked line, Fig. 6.

4. Lay the first tuck in the direction in which all the tucks must lie when finished; i.e., the upper side uppermost. Place the tuck marker in position along the line of running stitches, thus obtaining the position of the fold of the second tuck, Fig. 6.

5. Fold the material and tack the tuck along the line indicated by the marker, afterwards holding the tuck in position with running stitches, Fig. 6.

6. Continue with the formation of the remainder of the tucks in the same manner.

7. If the tucks are to be made of varying widths, then other tuck markers must be made and used in rotation.

If the tucks are always measured from the stitching of the previous tuck and tacked on the under side, the result will be quite satisfactory. It is a mistaken idea to think that the same results will occur if the tucks are measured from the last tuck when it is lying in its final position and the tacking is done on the upper side as in Fig. 7. The fold marked A is not in its correct position until the pressing is done, so that when the tucks have eventually been pressed the desired result is not obtained; instead the spaces between the tucks are wider than they ought to be (Fig. 8), thus making a considerable difference when all the tucking of the garment has been completed.

BRIEF INSTRUCTIONS FOR MAKING A GYM BLOUSE

Pattern.—Draft a shoulder yoke pattern by taking 2 in. from the front block pattern and ½ in. from the back block pattern. The back pattern is the remainder of the back block cut 1 in. longer. The front pattern is obtained from the remainder of the front block and consists of two separate parts altered as in Fig. 1. Draft a sleeve pattern, cuff, and Peter Pan collar.

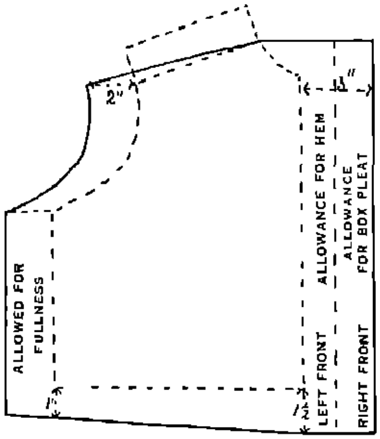


FIG 1

Computation of cost.—Kinds of material; widths; prices per yard; quantity required.

Cutting out.—Cut out all the separate portions, allowing turnings. When cutting out the blouse fronts do not cut out along the curve of the neck line until the box pleat and wrap are done, so that the correct shape will be obtained.

Making up.—Make the box pleat on the right front by folding in the turnings and felling a 1½ in. hem. Fold and press the hem into a box pleat so that the seam lies exactly down the middle on the wrong side. *Machine-stitch* ¼ in. from the edges of the box pleat. Make a 1 in. hem down the centre of the left front on the wrong side. Tuck the fronts to fit the yoke and set the fronts and back portion into the yoke, machining one row close to the edge and a second row ¼ in. away from the first. Join the under-arm and sleeve seams with a French seam. Make the wrist openings, set on the cuffs, and set in the sleeves. Make the collar and

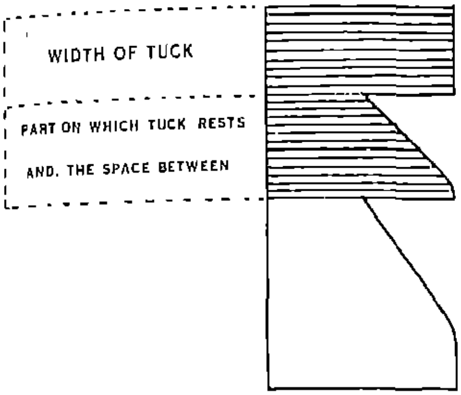
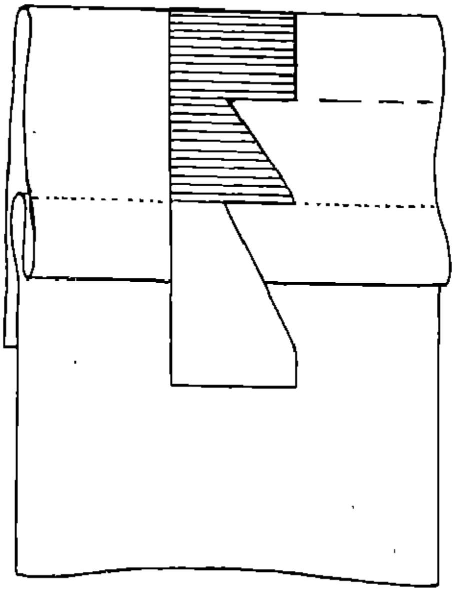
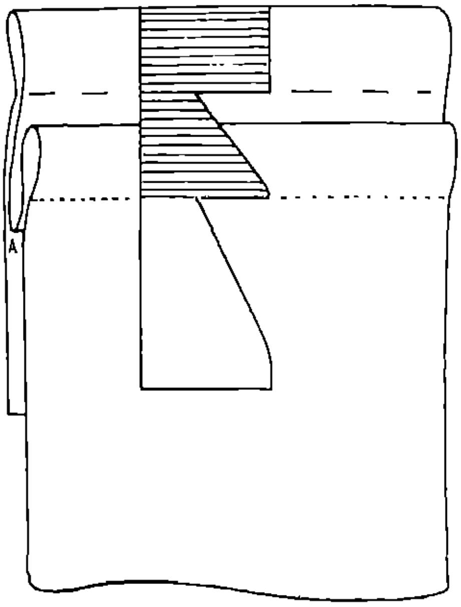


FIG. 5



CORRECT METHOD OF TUCKING

FIG. 6



INCORRECT METHOD OF TUCKING

FIG. 7

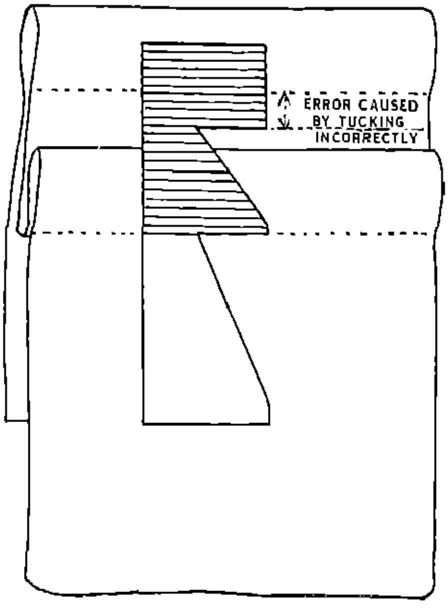


FIG. 8

attach it to the blouse. Make button and buttonhole fastenings down the centre front and at the cuffs. Turn a 1 in. hem along the bottom of the blouse, through which insert a piece of elastic to fit round the waist, Fig. 2.

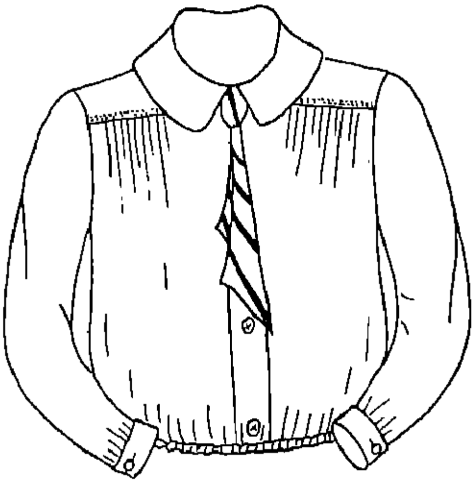


FIG. 2

VI. DECORATIVE STITCHERY

Arrangement of lesson.—As the teacher demonstrates, the pupils follow her step by step.

Teacher's requirements.—A piece of crash; coloured wools; needle; scissors; thimble; luncheon sets showing the application of the new stitches; sketches showing the different stages in the working of each stitch; easel; drawing pins.

Children's requirements.—The piece of crash used in Term I.; needle; embroidery cottons; thimble; scissors; pencil; notebook.

DEMONSTRATION

Raised chain stitch.—

1. Work a foundation of upright tacking stitches, about ¼ in. long, Fig. 1.
2. Bring the needle out at one end just above the first tacking stitch and prepare to work downwards over the transverse threads.
3. Pass the thread round the "bar" in the centre, bringing it up again to the left, Fig. 2.
4. Work a loop stitch as shown in Fig. 2.
5. Work this stitch over each bar in turn, Fig. 3.

Portuguese border and chain stitch.—

1. Work a foundation of transverse tacking stitches.
2. Using another colour of wool, bring the needle up just below the last bar to the left of the centre of the stitch.
3. Work two stitches round the last and the next bar without passing through the material, bringing the needle out under the second bar to the left of the two stitches, ready for beginning the next stitch, Fig. 4.
4. Continue these stitches until the end of the transverse stitches is reached, then repeat them on the other side, Fig. 5.
5. Work a chain line down the centre in another colour of cotton or wool, Fig. 6.

Long-and-short stitch.—This stitch is a variation of satin stitch and is very useful either for edging or filling in entirely, flowers or leaves. The stitches are worked alternately long and short instead of a uniform length, and may be so arranged that one end of the stitches forms a firm unbroken line and the other end a dentated line. Beginning with a line of long and short stitches for a solid filling enables the worker to introduce another harmonising shade in the irregular line formed on the inner edge, thus giving a softer and more pleasing effect to the embroidery.

Work long-and-short stitch in the same way as satin stitch. To gain the desired effect there must be a decided difference in the length of the stitches, Fig. 7.

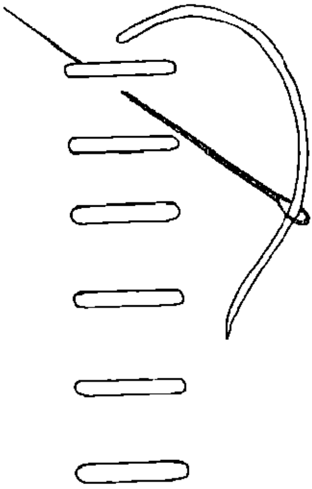


FIG. 1

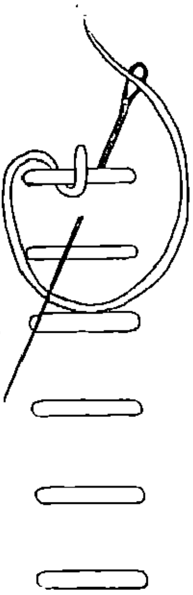


FIG. 2

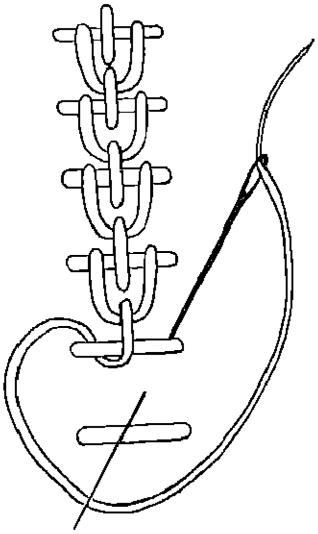


FIG. 3

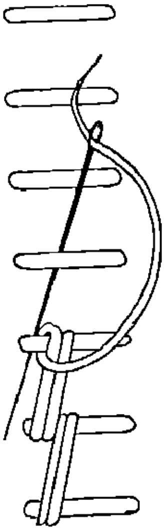


FIG. 4

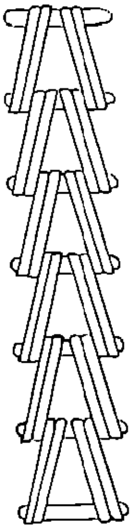
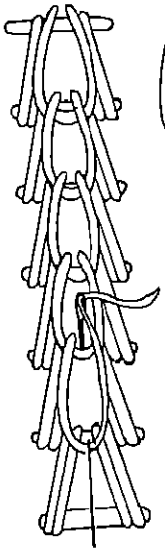


FIG. 5



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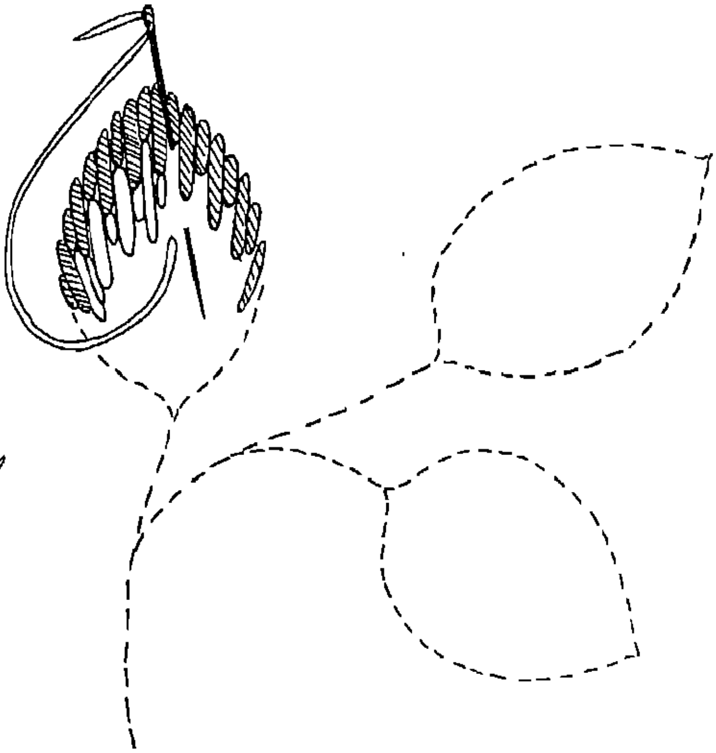


FIG. 7

BRIEF INSTRUCTIONS FOR MAKING TWO STYLES OF LUNCHEON SET

The first set consists of one large 20 in. circular mat, six 9 in. circular mats, and six 6 in. circular mats. Work the edges in close blanket stitches, cut away the surplus material and along the edge work a double row of blanket-stitched loops. Make a concentric circle inside the mat and break it with one or three groups of flowers. Work raised chain stitch or Portuguese border and chain stitch along the line; outline or fill in entirely the flowers and leaves with long-and-short stitch.

In the second set, Fig. 1, the shape is obtained from a circular piece of material, the four mats being sections cut away from

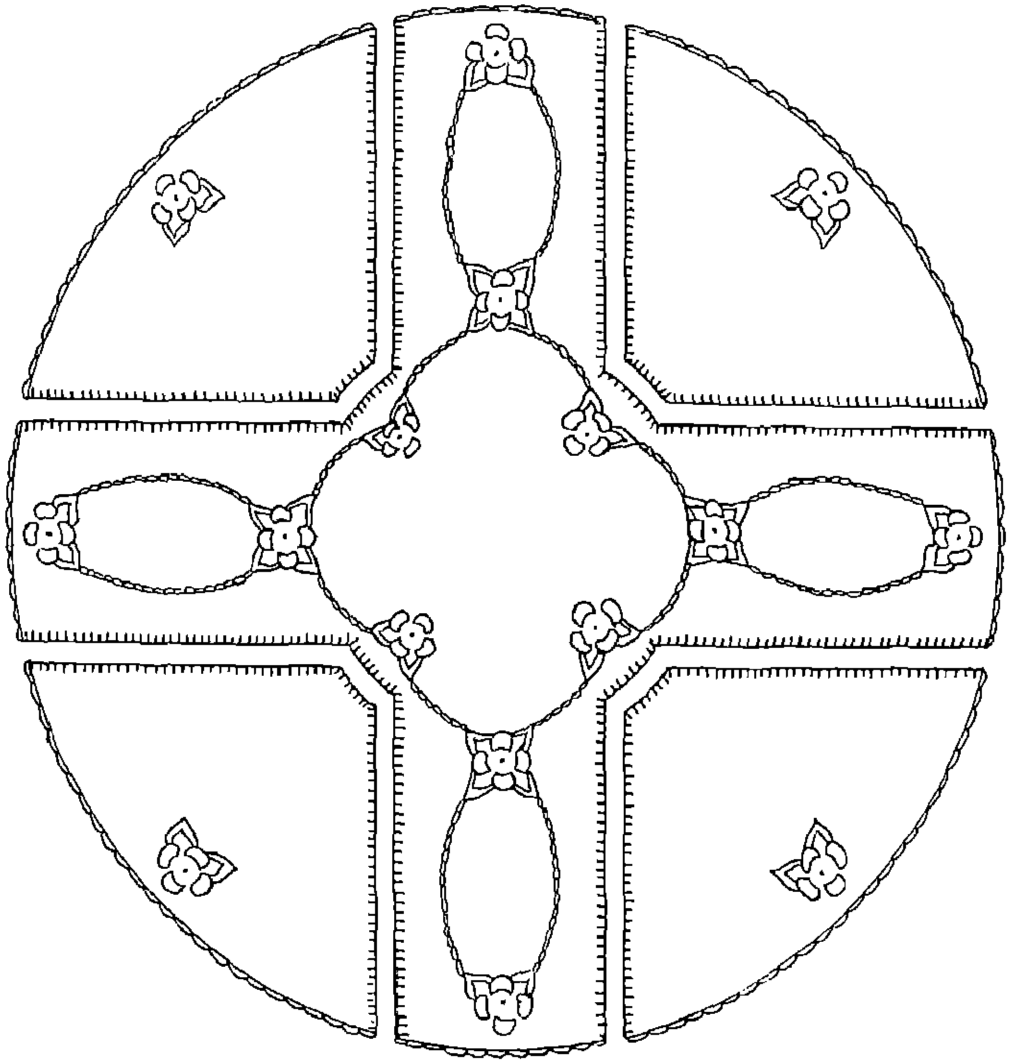


FIG. 1

the centre piece. Work the outside edges in scalloping and the inside edges in close blanket stitches. Trace on a design such as the one shown, and fill in the leaves and petals with long-and-short stitch. Make an eyelet hole for the centre of each flower. Use one of the border stitches already learnt to work the lines connecting the flowers in the centre piece.

VII. REPAIR WORK—DARNING TEXTILES—continued

Arrangement of lesson.—The pupils work the principles along with the teacher.

Teacher's requirements.—Articles or garments which have had a straight tear or three-cornered tear repaired in them; a large piece of material suitable for demonstration purposes; chart with illustrative sketches; easel; drawing pins; coloured wools; needle; scissors; thimble.

Children's requirements.—Pieces of material containing a straight tear and a hedge tear; cotton; needle; thimble; scissors; notebook.

DEMONSTRATION

Darning a tear.—As a tear always occurs along a straight thread there is no worn part around it, so that it is not necessary to avoid straight lines when darning, and therefore the rows of darning may contain an equal number of stitches. Single darning at right angles to the tear is usually sufficient.

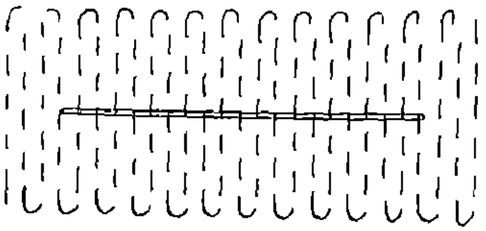


FIG. 1

At the edge of the tear take the stitch of the first row over one edge and under the other, and in the next row pass over the piece that was lifted, thus preventing the torn edges fraying, Fig. 1.

Darning a hedge tear or three-cornered tear.—

1. Draw the edges together on the wrong side with fishbone stitches in a contrasting colour before beginning to darn, Fig. 2.

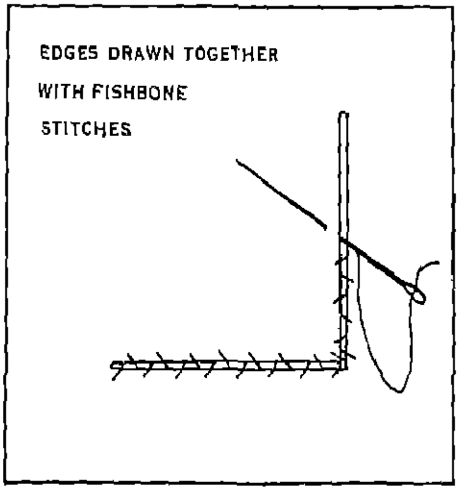


FIG. 2

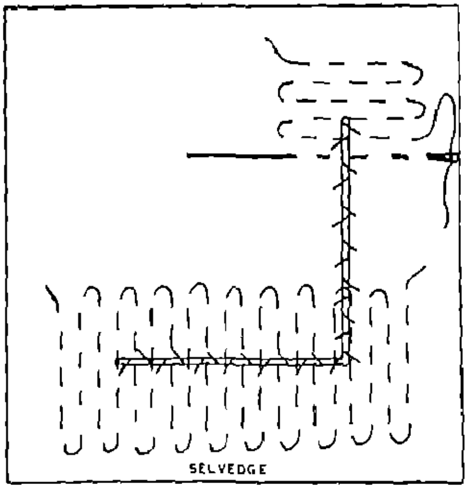


FIG. 3

2. Begin darning about ⅜ in. away from the cut and ⅜ in. to the left of the cut, selvedge way first.

3. Work single darning over the selvedge tear to ⅜ in. beyond the edge.

4. Turn the work round and darn over the weft tear in the same way, Fig. 3.

5. This results in the weakest part of the tear; i.e., the jagged corner, being covered with double darning stitch, the threads forming a pattern of steps, crosses or "T's," Fig. 4. When crossing the darn the material as well as the stitches must be taken up.

6. Remove the fishbone stitches.

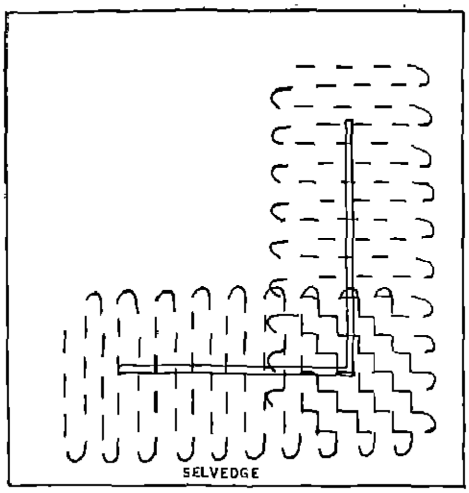


FIG. 4

SECOND YEAR COURSE—THIRD TERM

Pattern making.—Bodice; yoke; collar; sleeve; cuff.

Garment or article to be made.—Nightdress; duchesse set or luncheon set continued.

Knitting.—Jumper continued.

Processes.—Reducing fullness by means of smocking and honeycombing; faggoting.

Decorative stitchery.—Application of the stitches already learnt.

Repair work.—Darning textiles continued.

Discussion of work.—As a nightdress with inset sleeves is the garment to be made during the term, one should be exhibited to the class and its chief features discussed.

All details worthy of note should be referred to; e.g., processes already taught and new ones to be taught during the term. It will be noticed that the nightdress does not necessitate the introduction of any new draft but it is a combination of several of the drafts already taught.

Attention must be paid to the progress made by the pupils in their decorative article to ensure the completion of the article before the end of the term.

The pupils' knitted garment should be far advanced by this time, the chief point for discussion being the general finish and appearance of the jumper.

Articles or garments containing a repaired cross cut and a tear repaired with machining should be on view when the repair work for the term comes under discussion.

I. SMOCKING AND HONEYCOMBING

Aim of lesson.—To teach the pupils how to dispose of fullness in a decorative manner.

Arrangement of lesson.—The pupils follow each process on their samplers as the teacher demonstrates.

Teacher's requirements.—A large piece of hessian; coloured wools; needle; scissors; thimble; pins; a garment where smocking and honeycombing have been introduced; a chart showing the various stages in the working of these decorations; easel; drawing pins.

Children's requirements.—A piece of material suitable for smocking; cotton; needle; pins; scissors; thimble; embroidery cottons; notebook.

Introduction.—Smocking and honeycombing are two decorative methods of reducing fullness in a garment, and they may be combined or used separately. For both methods the material is prepared in the same manner, but the method of working differs in that the embroidery threads may produce a variety of patterns when smocking is completed, whereas honeycombing always results in a diamond-shaped pattern which allows the material to be opened out wider than smocking when worked. These methods of reducing fullness take up from three to four times the finished width of material, as the material is gathered by several threads. Rows of horizontal gathering stitches are worked very accurately over the desired space, the length of each stitch depending upon (1) the thickness of the material (for fine materials the stitches are $\frac{1}{4}$ in. apart), and (2) the amount of fullness to be disposed of (smaller stitches being required if the fullness is scanty). Every row of gathering stitches is worked exactly below the one above, beginning with a large knot and not a back stitch, to enable the threads to be removed easily when the smocking is completed. To ensure regularity of gathering, it is best to mark the wrong side of the cloth with lines of dots which may be correctly placed by (1) using a long ruler and a pencil; (2) means of a transfer paper; or (3) marking the dots on tissue paper, making the stitches through the paper and material and afterwards tearing away the paper.

Working the gathering threads.—There are four ways in which the material may be taken up with the needle.

1. Picking up the alternate spaces.
2. Placing the needle in at a dot and bringing it out in the middle of a space.
3. Lifting a small piece of the material at each dot.
4. Picking up most of the material on each side of a dot.

Fig. 1 shows the four methods being worked.

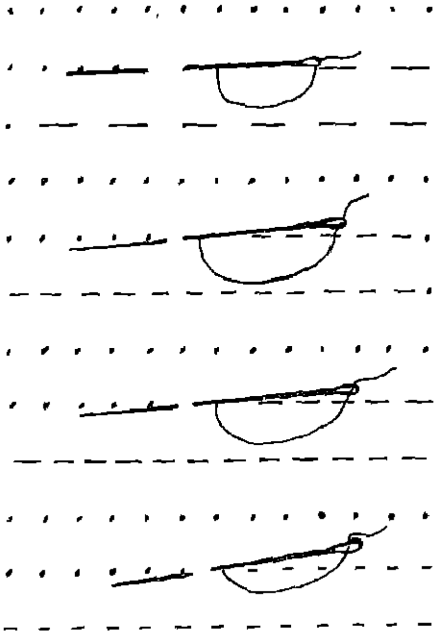


FIG. 1

DEMONSTRATION

To work smocking.—

1. Insert all the rows of gathering threads.
2. Draw up the material tightly to straighten the flutes, then loosen to $\frac{1}{3}$ of the width of the space to be covered, afterwards winding the threads round pins in pairs as shown in Fig. 2.
3. Work various patterns with embroidery threads on the surface of the flutes on the

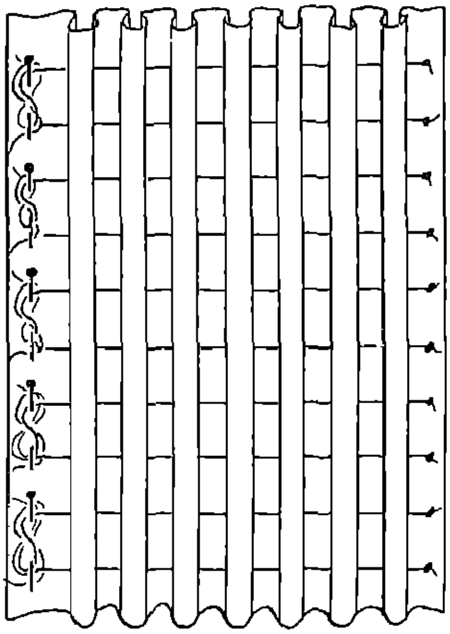


FIG. 2

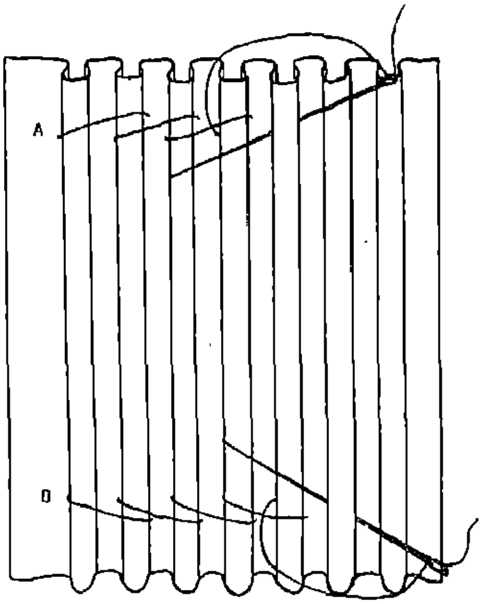


FIG. 3

right side of the material, making a very secure beginning at the back of the position of the first stitch.

4. Fig. 3 shows two ways of working outline stitch, the upper line A being worked with the thread always placed above the needle, while the lower line B is worked with the thread lying below the needle. In each case the needle passes through one flute only, and the thread should not be drawn tightly.

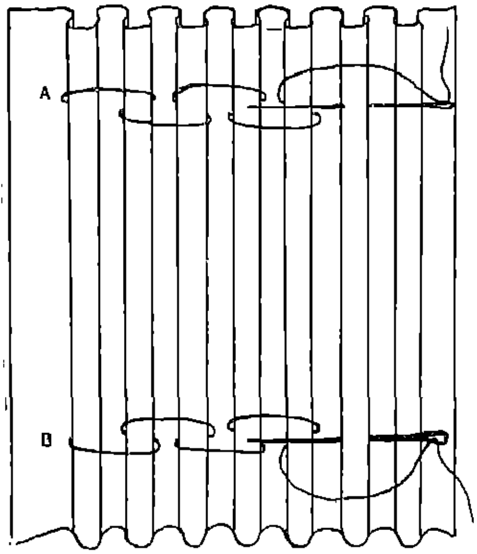


FIG. 4

5. Variations of outline stitch are shown in Fig. 4. In the upper line A the pattern is formed by the cotton lying above the needle for the first stitch and below the needle for the second stitch, and so on. The lower line B is worked in a similar manner, beginning with the cotton lying below the needle for the first stitch. A pretty effect may be obtained by placing the two lines of stitches so close together that the upper stitch of the bottom row almost touches the lower stitch of the top row.

6. Lines of chain stitching or feather stitching may be worked as decorative patterns over the flutes, Fig. 8.

7. Fig. 5 shows the working of the pattern known as "basket stitch." This is worked in the same way as Fig. 4, a long stitch being made between the first and second, and the third and fourth flutes, etc., during the working of the outline stitches, to form one-half of the depth of a diamond-like pattern, which is completed after working line B.

8. Remove all the gathering threads.

To work honeycombing.—

1. Insert all the rows of gathering threads. The spaces between the rows determine the length of the "diamond," as the stitches are worked at the same level as these threads.

2. Draw up the material tightly, then loosen to $\frac{3}{4}$ the width of the space to be covered, winding the threads round pins.

3. Working from left to right, begin securely on the wrong side, then take the needle to the right side through the first flute along the top gathering thread.

4. Make a stitch over the first and second flutes, passing the needle out where the thread hangs loose, Fig. 6 (A).

5. Make another stitch over the first, passing the needle down the back of the second flute and bringing it out at the second gathering thread, Fig. 6 (B).

6. Work the same stitches now over the second and third flutes, passing the needle up along the back of the third fold and bringing it out again at the first gathering thread, Fig. 6 (C) and (D).

7. Repeat these two processes along all the flutes on the first two threads, afterwards working over the remaining threads in pairs in the same manner, Fig. 7.

8. Honeycombing looks very effective when combined with smocking, especially if worked to form a Vandyke pattern as in Fig. 8.

N.B.—In honeycombing, each stitch passes through two flutes of material, the flutes joined by one line of stitches being separated on the next line. If smaller "diamonds" are required, the second line of stitches is worked half-way between the top and second gathering threads.

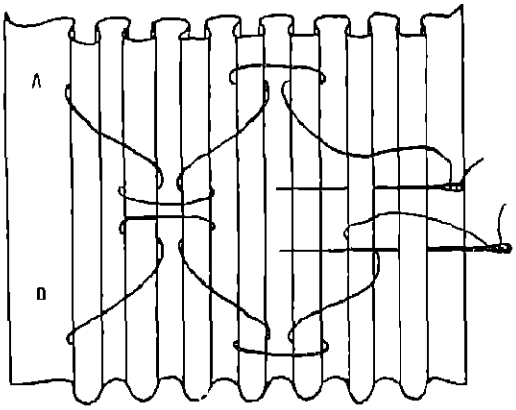


FIG. 5

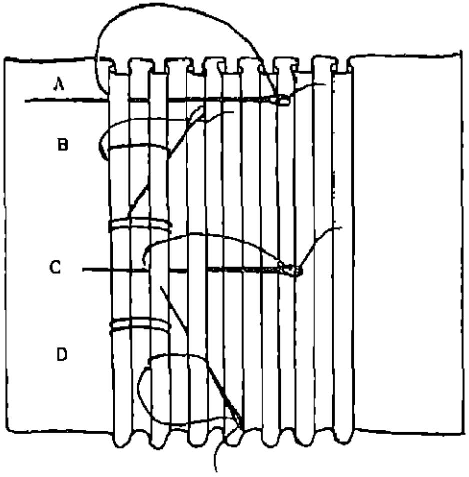


FIG. 6

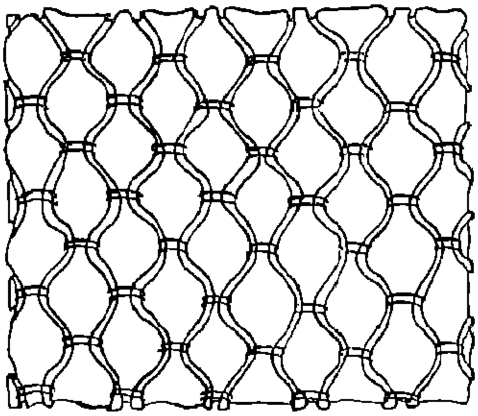


FIG 7

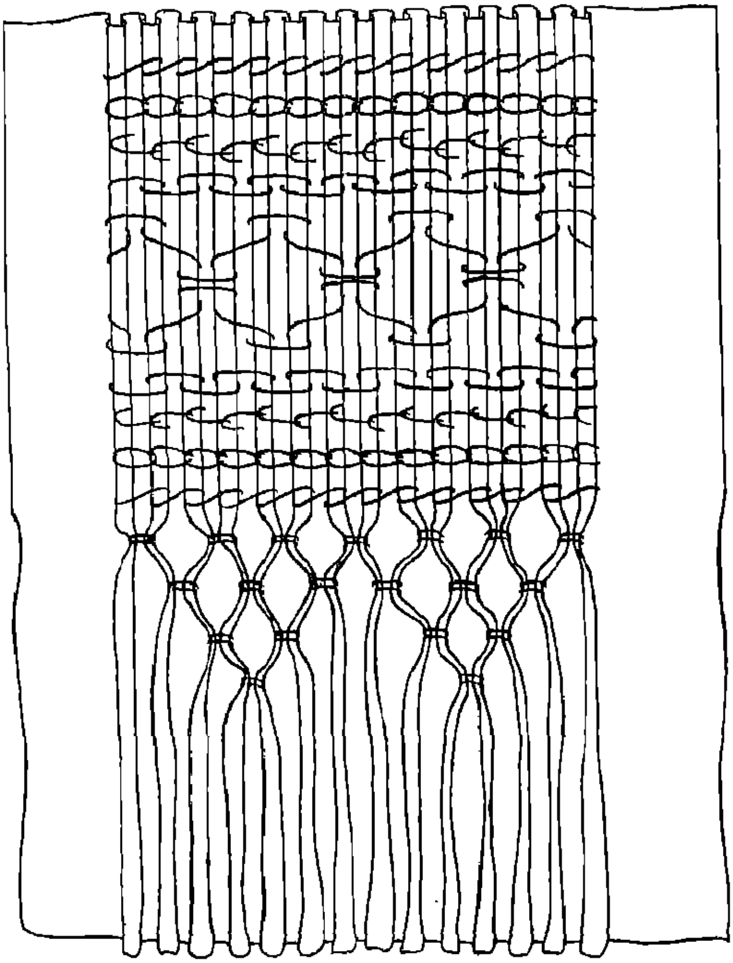


Fig. 8

II. FAGGOTING

Aim of lesson.—To teach the pupils how to join two pieces of material in a decorative manner.

Arrangement of lesson.—As in previous lessons, the pupils work each step as the teacher demonstrates.

Teacher's requirements.—A piece of crash; a strip of crash; coloured wools; a strip of paper; needles; scissors; thimble; chart showing the different kinds of faggot stitch; blackboard; drawing pins; nightdress with armhole and neck edges finished with faggoting.

Children's requirements.—A piece of crash; a strip of crash; a strip of paper; cotton; needle; embroidery cotton; scissors; thimble; notebook.

Introduction.—Faggoting is worked between two edges of material instead of on a flat surface, and is used for joining parts of a garment or decorating hems with strips of material, lace insertions, or bands of ribbon. When decorating an edge with strips of material the strips set better if cut on the direct cross, especially if the edge is curved. Before beginning to work, prepare the material to be joined by tacking the edges on to stiff paper, keeping a uniform width between the two edges. This prevents the faggoting from being drawn tighter in some places than others.

DEMONSTRATION

To prepare the material.—

1. If a strip is being attached, turn in the edges, fold the material in two lengthways, and tack the turned-in edges together.

2. Tack the strip on to a piece of stiff paper with the fold to the outside edge of the paper, Fig. 1.

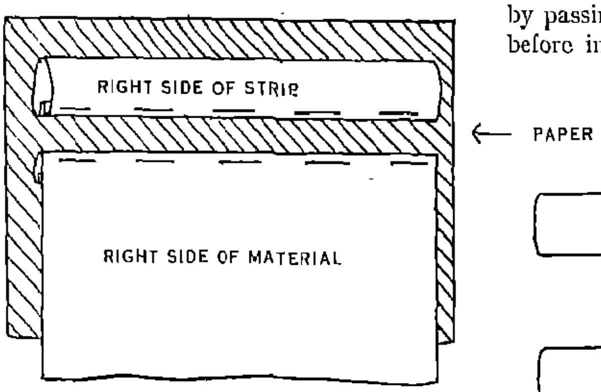


FIG. 1

3. Turn down a fold along the edge of the garment and run on the machine. Turn down a second fold and tack to the paper with the folded edge opposite to, and the required distance away from, the turned-in edges of the strip of material, Fig. 1.

Working the faggot stitch.—

1. Commence by running the thread through the folds of the material and making a back stitch on the under side of the turned-in edge, afterwards bringing the needle out at the edge.

2. Pass the needle through the opposite edge from the right side to the under side, to form a stitch at an angle to the left of the first stitch, and make the looped effect by passing the needle over the thread which is held under the left thumb, Fig. 2. This is the simplest form of faggot stitch.

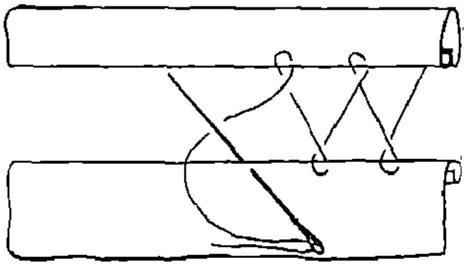


FIG. 2

3. A more complicated stitch is that forming a twist as shown in Fig. 3. Work this as for the simple stitch and obtain the twisted effect by passing the needle round the thread once before inserting it in the opposite edge. If desired the twist may be "locked" by passing the needle round the thread a second time and bringing it out through the first twist. Fig. 4.

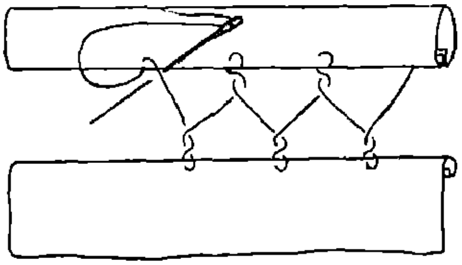


FIG. 3

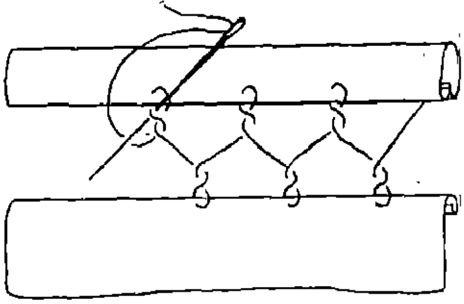


FIG. 4

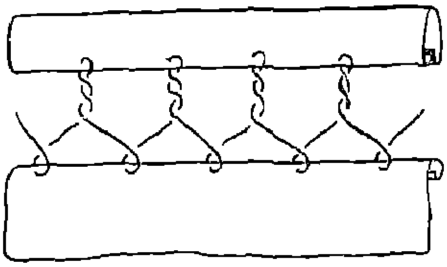


FIG. 5

Fig. 5 shows the simple stitch elaborated to form a more twisted effect along one edge only.

4. A straight faggot stitch may be worked to have a pleasing effect as shown in Figs. 6A and 6B. In this case, insert the needle in the opposite edge from the under side of the material to form a straight stitch, Fig. 6A. Afterwards pass the needle round

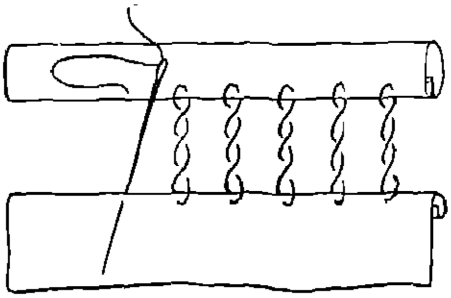


FIG. 6A

the straight strand two or three times; then insert the needle from the back to the right of the last stitch and slip it between the folds to the front fold ready to form the next stitch, Fig. 6B.

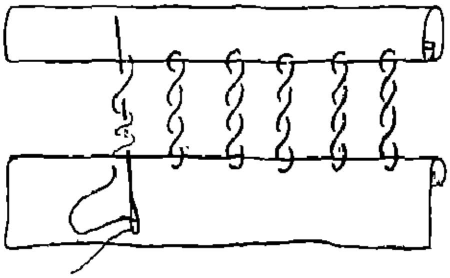


FIG. 6B

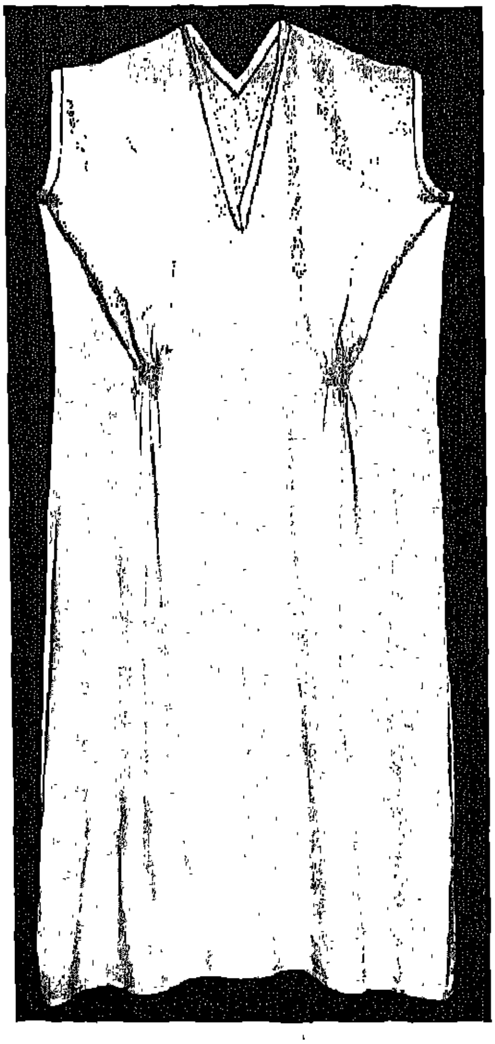
BRIEF INSTRUCTIONS FOR MAKING A NIGHTDRESS WITH INSET SLEEVES

Measurements required.—

1. Length:—(*a*) from shoulder to ankle; (*b*) from base of yoke to ankle.

2. Width:—along the bottom of the nightdress.

3. Sleeve:—length required (*a*) if only to reach to the elbow; (*b*) to wrist if setting in a cuff, or (*c*) to wrist plus extra for frill.



NIGHTDRESS SHOWING FAGGOTING, SMOCKING AND HONEYCOMBING

4. Depth of yoke, if one is required.
5. Depth of cuff, if one is required.
6. Width of collar, if one is required.

Drafting the pattern.—

1. Extend the bodice pattern to obtain the pattern of the nightdress, making the necessary alterations described in previous lessons.
2. Draft the yoke, cuff and collar patterns to the required measurements, and shape according to taste.
3. Draft the sleeve pattern.

Computation of cost.—Kinds of material; widths; prices per yard; quantity required.

Cutting out.—Cut out the required sections, allowing enough for turnings and gathers or tucks where necessary. It is better to tuck the material before laying on the pattern to ensure the garment being the correct size when completed.

Making up the nightdress.—Machine all the seams and the hem along the bottom. Make up the front opening, yoke, cuffs and collar, and set in the sleeves. When setting the sleeves in a yoked garment, they are set into the right side of the yoke only, the under-arm holes being neatened with a crossway binding which extends a little way under the yoke, the inner yoke afterwards being folded down over the remaining raw edges and hemmed to the turning. If the sleeve has to end in a frill at the wrist, arrange the gathers under a crossway strip before the sleeve seam is sewn. Decorative stitchery may be worked on the yoke, opening, cuffs and collar if desired.

Fig. 1 shows a nightdress tucked into a yoke, the opening being made in the form of a box pleat, to the edge of which lace is attached by means of decorative stitchery; e.g., feather stitch, and the sleeves arranged to form a frill at the wrist.

In Fig. 2 the fullness is smocked into an imitation yoke, short sleeves are smocked into a narrow band, and the collar has a blanket-stitched scalloped edge. Figs. 1 and 2 show styles suitable for children.

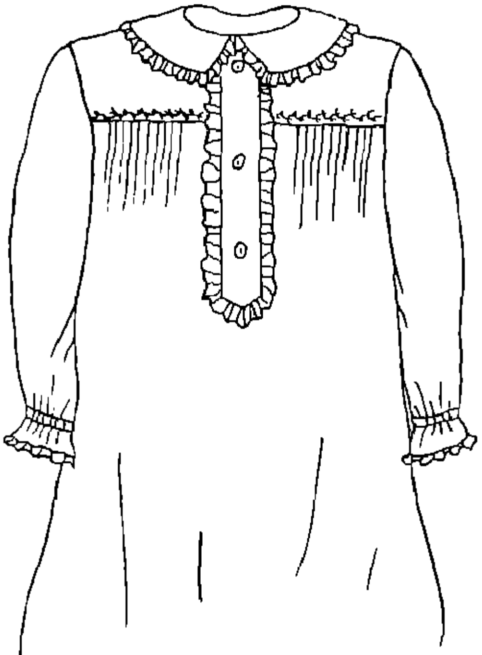


FIG. 1

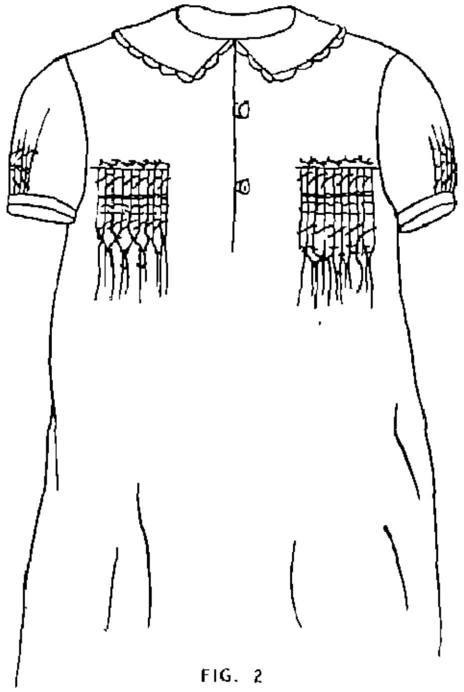


FIG. 2

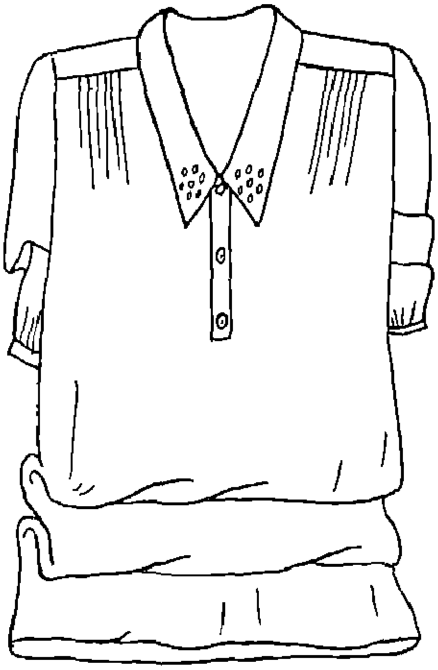


FIG. 3

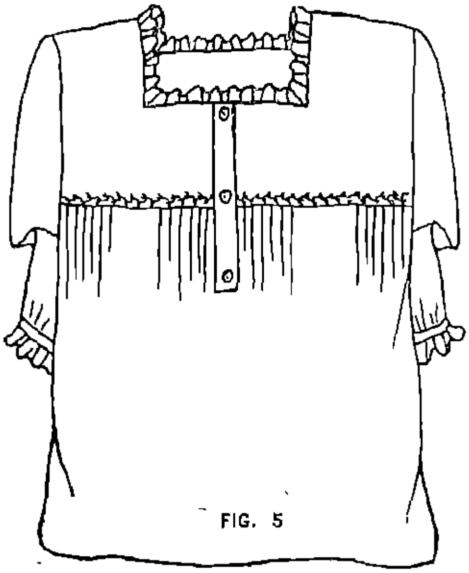


FIG. 5

Figs. 3, 4 and 5 show nightdresses having the fullness tucked into different forms of yokes, the long sleeves being set into a cuff or band in each case. If a nightdress without sleeves is desired, then the armholes and neck edge may be neatened with a band of the material joined to the nightdress by means of faggot stitch, Fig. 6.

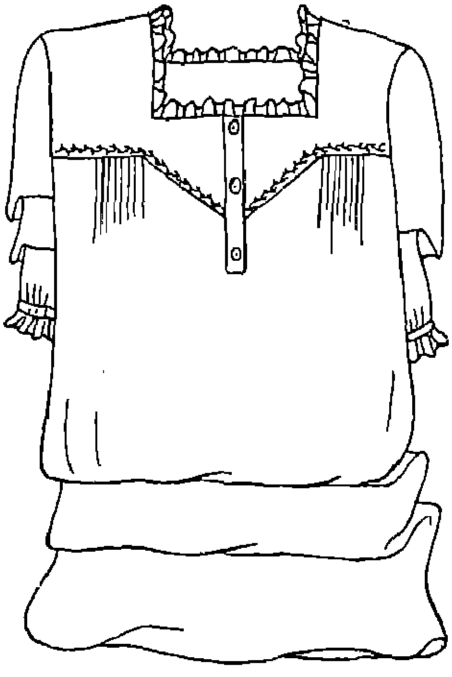


FIG. 4

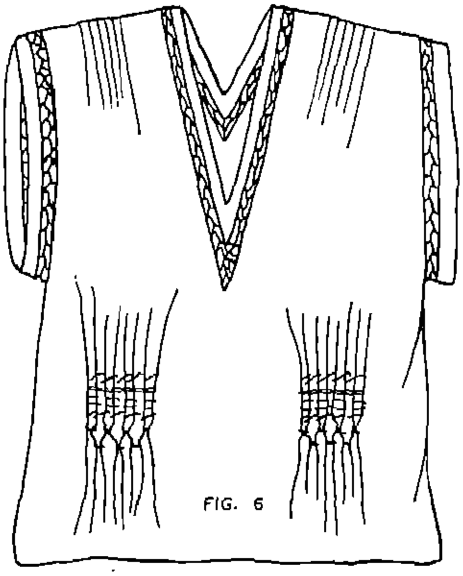


FIG. 6

III. REPAIR WORK—DARNING TEXTILES—continued

Arrangement of lesson.—As in previous lessons, the pupils work along with the teacher.

Teacher's requirements.—Articles or garments which have a cross cut and a tear repaired in them; a large piece of material suitable for demonstration purposes; chart with illustrative sketches; easel; drawing pins; coloured wools; needle; scissors; thimble.

Children's requirements.—Pieces of material containing a cross cut and a straight tear; cotton; needle; thimble; scissors; notebook.

DEMONSTRATION

Darning a cross cut.—A cut may occur at an angle crossing both warp and weft and, therefore, darning must be worked in both directions. As the edges are liable to fray badly the darn should be worked immediately. The darning is worked along the threads of the material and not at right angles to the cut. As there is no worn part around the cut, the darn must cover as small a space as possible, double darning covering the cut to strengthen the weak place, and single darning worked round to reduce gradually the bulkiness of the darn.

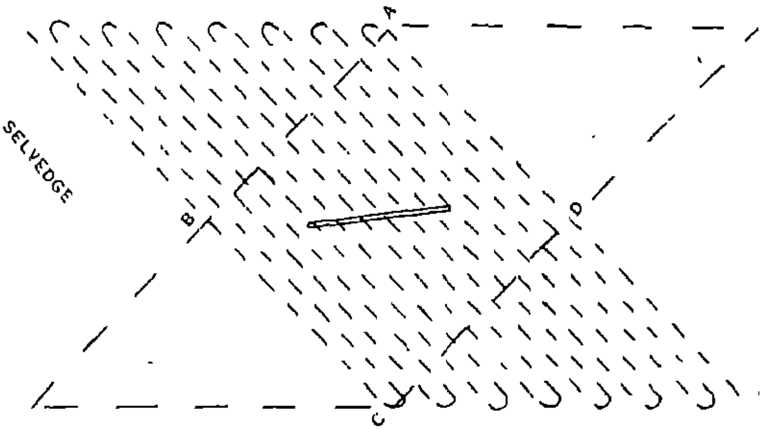


Fig. 1

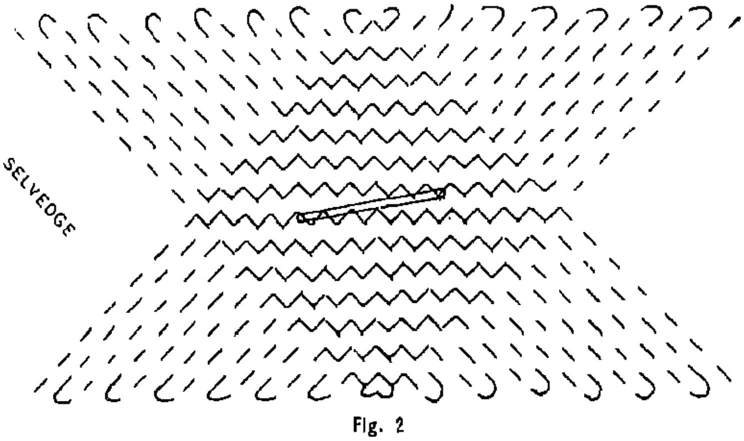


Fig. 2

1. Darn the cut edges together with fishbone stitches.

2. Tack-mark or draw on the wrong side of the material a square to enclose the cut, the sides of which are ¼ in. away from the cut, ABCD, Fig. 1.

3. Begin darning along one selvedge side of the square, starting at one of the corners farthest away from the cut, count the number of stitches made and, continuing with the same line, work a similar number of sitches.

4. Decrease on the next line and work the same number of stitches.

5. Continue working an equal number of stitches in every row of darning until the opposite side of the square is reached, thus forming a rhomboid or parallelogram, Fig. 1.

6. Turn the work for crossing, and begin at the same point as before, Fig. 1.

7. Darn a second rhomboid along the weft threads, taking up the material along with the darning threads when crossing, Fig. 2.

8. Remove the fishbone stitches.

Darning a tear with machining.—A long tear in any coarse household linen may be repaired by hand darning or machining the edges together over a piece of tape or strip of material placed under the tear on the wrong side, Fig. 3.

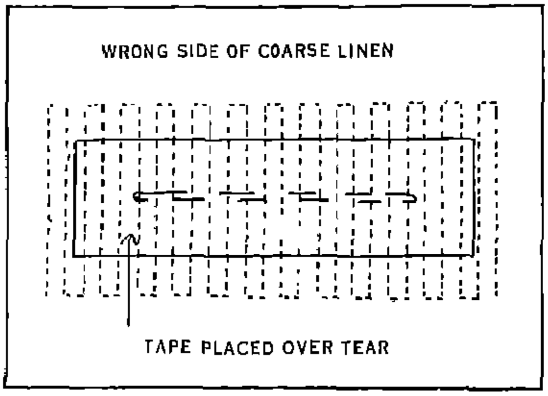


FIG. 3

THIRD YEAR COURSE—FIRST TERM

Pattern making.—Skirt—block pattern and its adaptations.

Garment or article to be made.—Skirt; chair-back covers.

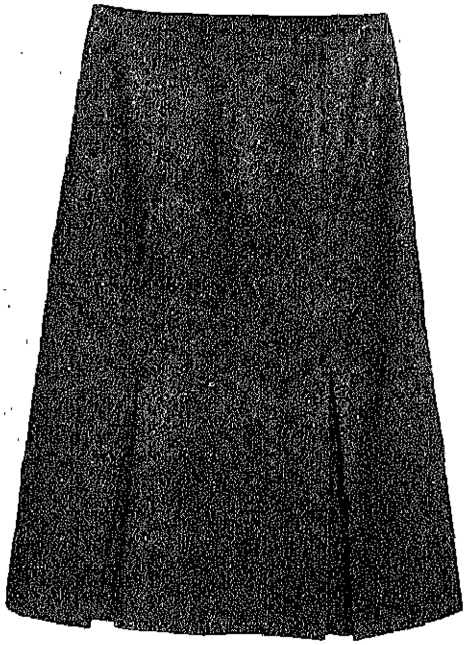
Knitting.—Bathing suit begun.

Processes.—Reducing fullness by means of darts; setting the skirt on a petersham band; turning the hem of a skirt; bound buttonholes.

Decorative stitchery.—Couching; appliqué work; further application of stitches already learnt.

Repair work.—Care of household linen; uses of old household linen.

Discussion of work.—By this time the pupils should be sufficiently conversant with the principles of needlework to allow for the introduction of simple dressmaking. Skirts of several different styles should be exhibited, their salient features noted, and attention drawn to the fact that one block pattern which consists of a plain two-piece skirt when adapted will produce almost any style of skirt. The different ways of supporting a skirt must be considered: (1) attached to a bodice lining, or (2) supported by a petersham band round the waist. Petersham is strong webbing having bones as supports at



Skirt Supported by a Petersham Band and Showing Inverted Pleats

arious intervals, and may be bought in arrow or wide widths. As the narrow lower dge of the webbing is the waist edge, it auses the skirt to be slightly high-waisted, nd allowance must always be made for this n the length when cutting out the skirt. he various processes involved in the naking up of the skirt should be referred o, and the general finish of the garment oted.

Chair-back covers provide suitable articles or the application of the decorative stitchery o be taught during the term. As these are ery popular in almost every household, reat eagerness will probably be shown by he girls to examine the teacher's completed overs and discuss the new stitchery.

For the year's knitting, a bathing suit rovides ample scope for variety of design nd pattern.

Renovated articles made from old houseold linen should be displayed when discussing the repair work for the term, and the economical values of such renovations should be stressed.

After the discussion of the term's work the skirt pattern may be considered. It will be noticed that surplus material round the waist in this pattern is reduced by means of darts so that it will be as well to commence the term with a lesson on darts before drafting the skirt pattern.

I. REDUCING FULLNESS BY MEANS OF DARTS

Aim of lesson.—To teach the pupils the flattest method of reducing fullness.

Arrangement of lesson.—The pupils follow the teacher's demonstrations, working with her on their own samplers step by step.

Teacher's requirements.—A large piece of hessian; coloured wools; needle; tape measure or ruler; a band of hessian into which the material must be fitted; blackboard showing the illustrations; easel; drawing pins; pins; scissors; thimble; a skirt and a jumper showing the application of darts.

Children's requirements.—A piece of material; a band into which it must be fitted; cotton; needle; scissors; thimble; pins; ruler or tape measure; notebook.

Introduction.—Darts are the flattest method of reducing fullness. It is the method frequently adopted to reduce the fullness of material in the making of a skirt which has to fit to the shape of the figure round the waist. In the making of a jumper for a person with a full figure, width is required round the bust, and this may be disposed of at the shoulder seams by means of very small darts. They always occur on the wrong side of the material.

DEMONSTRATION

To arrange darts.—

1. Measure the surplus material, decide the number of darts to be made, and divide the material up accordingly so that the darts are equal.

2. Where a dart has to occur, form a pleat at right angles to the edge of the material, and let it taper to a point several inches down, Fig. 1.

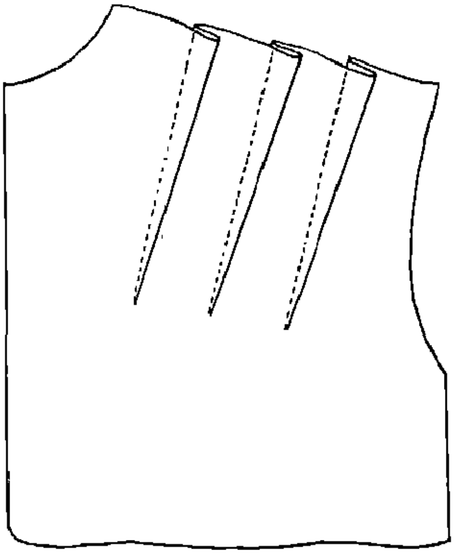


FIG. 1

3. To determine the position of this point, pin up all the darts required, and test the width and general appearance. If the garment appears to slope too quickly, make more but smaller darts, or if the material bulges make longer darts.

4. Run or machine all the darts and press the seams. If the pleat is narrow, fold down the material to one side, and, if necessary, slip-hem it. If the pleat is wide and the material is of a thick texture, cut it down the centre almost to the point, overcast the raw edges and press them out flat, Fig. 2.

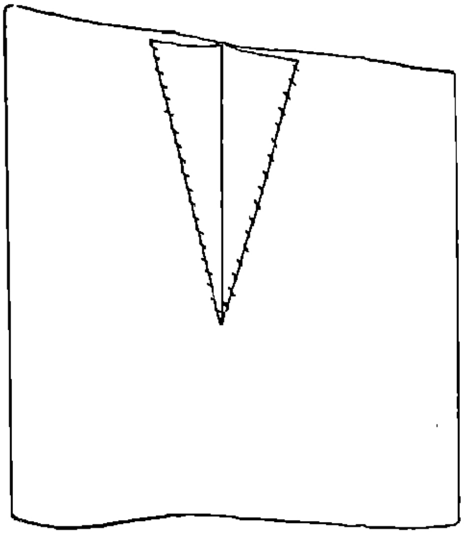


FIG. 2

II. DRAFTING THE "BLOCK" PATTERN OF A SKIRT

Arrangement of lesson. — The teacher demonstrates the drafting of the pattern on a large piece of paper pinned to the blackboard, the pupils working with her step by step.

Teacher's requirements.—Several sheets of drafting paper; coloured pencils; ruler; tape measure; scissors; blackboard on which the "block" pattern is illustrated; spare blackboard; a drafted pattern; drawing pins; different styles of skirt; drafted patterns of the different skirts.

Children's requirements.—Several sheets of drafting paper; pencil; ruler; tape measure; scissors; notebook.

DEMONSTRATION

Measurements required.—

1. Length round the waist.
2. Length round the hips.
3. Length from the waist to the depth required plus allowance for hem.

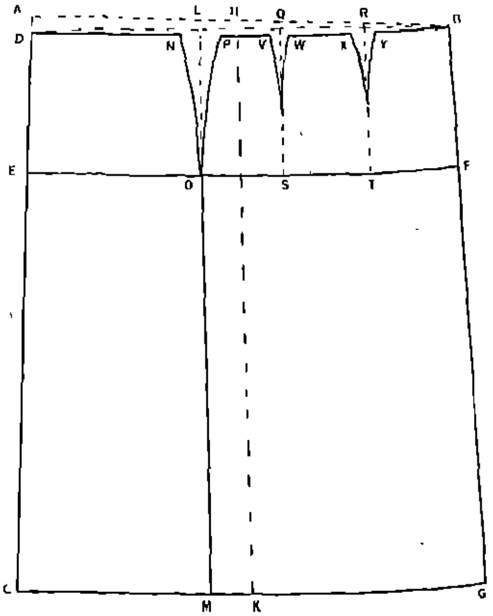


FIG. 1

Drafting the "block" pattern, (Fig. 1).—

1. Draw a horizontal line AB equal to half the hip measurement.

2. From A draw AC at right angles equal to the length of the skirt plus 1 in.

3. AD = 1 in. for the curve of the waist-line.

4. Join DB with a straight line, afterwards joining with a curved line and curving ¼ in. in the centre H.

5. DE = 7 in. (to obtain the position of the hip line).

6. Curve the hip line 7 in. below the waist-line.

7. EF = ½ hips plus 1½ in. for freedom of movement.

8. Draw from B a straight line passing through F.

9. BG = DC = length of skirt.

10. K = ½CG. Join HK with a dotted line.

11. KM = HL = 2 in. (*to obtain the* position of the side seam).

12. NL = LP = 1 in. (for the curve of the side seams to the hip line).

If fullness is not desired at the back, then it is reduced by means of darts as follows:—

(*a*) Divide LB into three equal parts at Q and R.

(*b*) Divide OF into three equal parts at S and T.

(*c*) Join QS and RT.

(*d*) QV = QW = RX = RY = ½ in. Dart down about 3½ in.

If no gathers at all are required round the waist, remove the surplus material by increasing the size or number of the darts until only the waist measurement is left.

Cut through the points CDNOM for the front pattern and through BGMOP for the back pattern.

Adaptation of "Block" Pattern

A pleated skirt (Fig. 2).—

1. Using the front portion of the block pattern, decide the position of the pleats.

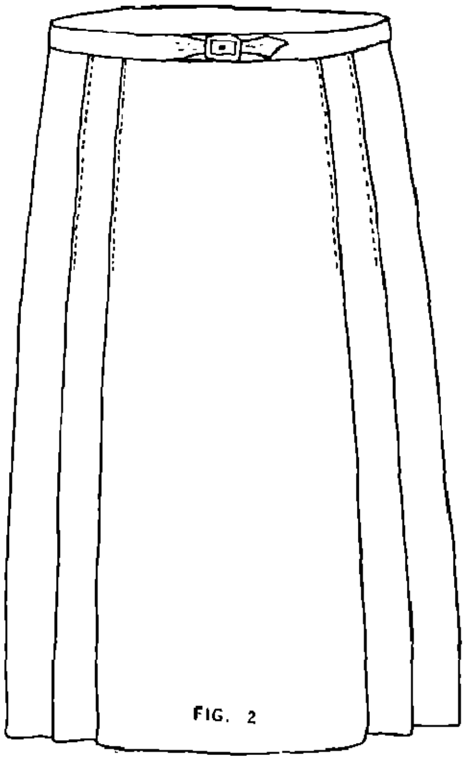


FIG. 2

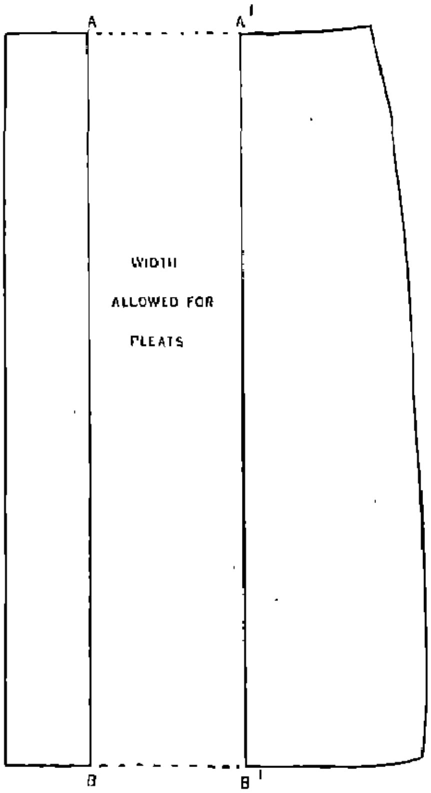


FIG. 3

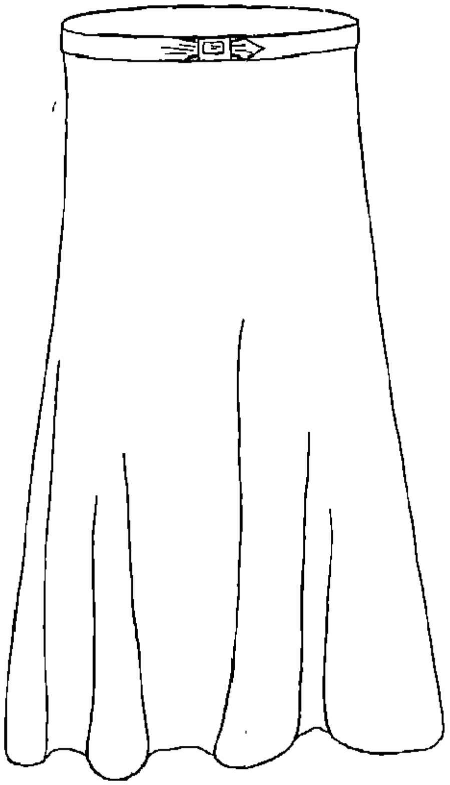


FIG. 4

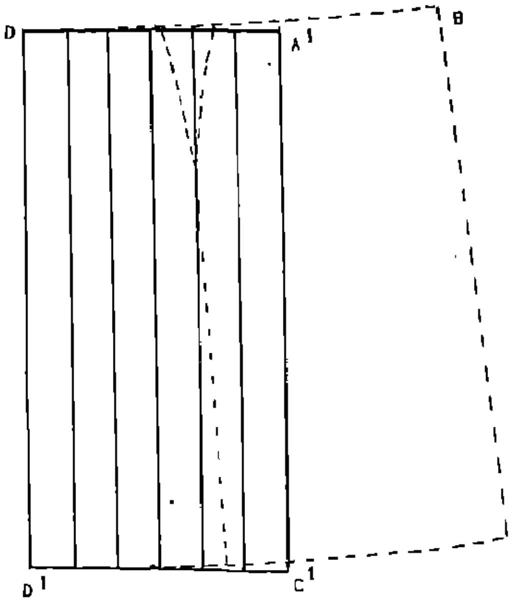


FIG. 5

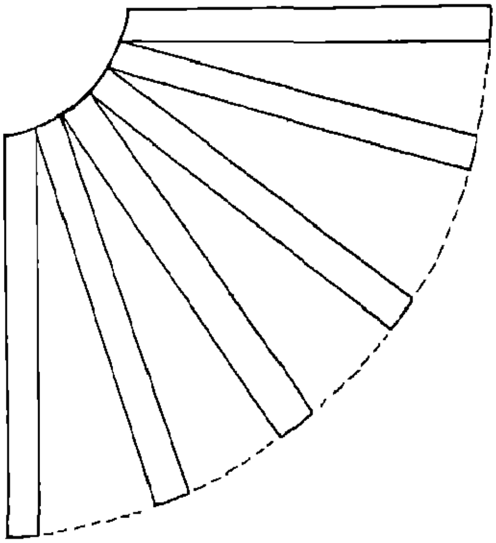


FIG. 6

2. Measure the distance of the position from the centre front along the top and bottom edges, and join the two points A and B, Fig. 3.

3. Cut along the line so that the pieces may be opened at AB and A^{1}B^1, wide enough to allow for the number of pleats required.

4. Treat the back pattern in the same way if pleats are required at the back of the skirt.

A flared skirt (Fig. 4).—

1. Draft the block pattern without allowing for a hem in the length.

2. Along DB measure DA^1 equal to half the waist measurement (top edge of the petersham band), Fig. 5.

3. Form the oblong DA^{1}C^{1}D^1 on the line DA^1, Fig. 5.

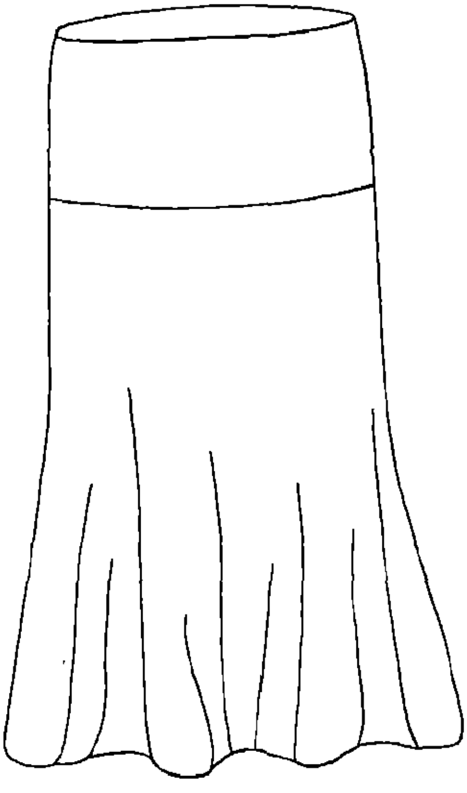


FIG. 7

4. Divide the oblong into six equal parts and cut up each section to $\frac{1}{8}$ in. from the waist line, Fig. 5.

5. Open the sections to the width required. This varies according to the width of the flare required. The more the sections are opened, the wider the flare becomes, Fig. 6.

6. Mark all round the outside edges to obtain the flared pattern. Cut out on this line (indicated by the dotted line in Fig. 6).

A flared skirt with a hip yoke (Fig. 7).—

1. Cut off the block portion at the hips.

2. Divide the top portion into four equal parts.

3. Take out in darts from the waistline the surplus material over and above the waist measurement (top edge of petersham band), Fig. 8.

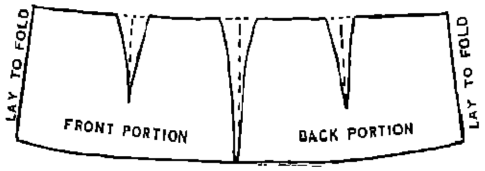


FIG. 8

4. Separate the front and back portions, fold over the darts in each, place the centre back and the centre front to the fold of another sheet of drafting paper, and cut out to obtain the pattern of the hip yoke, Figs. 9A and 9B.

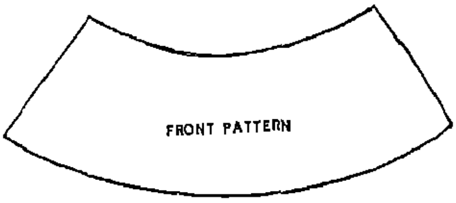


FIG. 9A

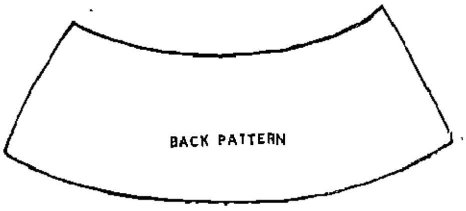


FIG. 9B

If there is a great difference between the hip measurement and the waist of the wearer, then the curve of the back yoke may be too pronounced. To modify this, lower the side seam of the yoke 1 in., Fig. 10.

5. Alter the remainder of the "block" pattern to form a flared skirt.

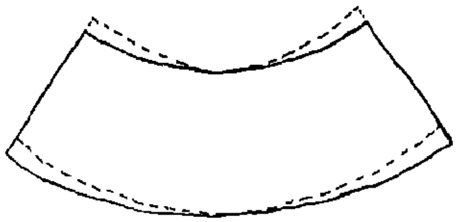


FIG. 10

III. SETTING THE SKIRT ON A PETERSHAM BAND

Arrangement of lesson.—As the teacher demonstrates, the pupils carry out the process on their own skirts.

Teacher's requirements.—A piece of material to represent a skirt; petersham banding; two hooks and eyes; coloured wools; needle; scissors; thimble; skirt supported by a petersham band.

Children's requirements.—A skirt; petersham band; two hooks and eyes; cotton; needle; scissors; thimble.

DEMONSTRATION

1. Make the petersham band long enough just to meet round the waist, allowing 1 in. extra at each end for turnings.
2. Fold in the ends, and herring-bone.
3. Sew two hooks on one edge and two eyes on the other edge with very strong cotton.
4. Tack-mark the centre front and the centre back of the skirt.
5. Fold down the turnings at the waist edge and place two gathering threads along the back from side seam to side seam. If gathers are not desired, then more darts are necessary.
6. Tack-mark the centre front, side seam, and centre back of the petersham band. When determining these positions, the worker must bear in mind that when the band is attached, the end with the eyes is placed right to the end of the extending fold, but the end with the hooks is placed as far from the end on the upper side of the placket as the opening overlaps, Fig. 1.

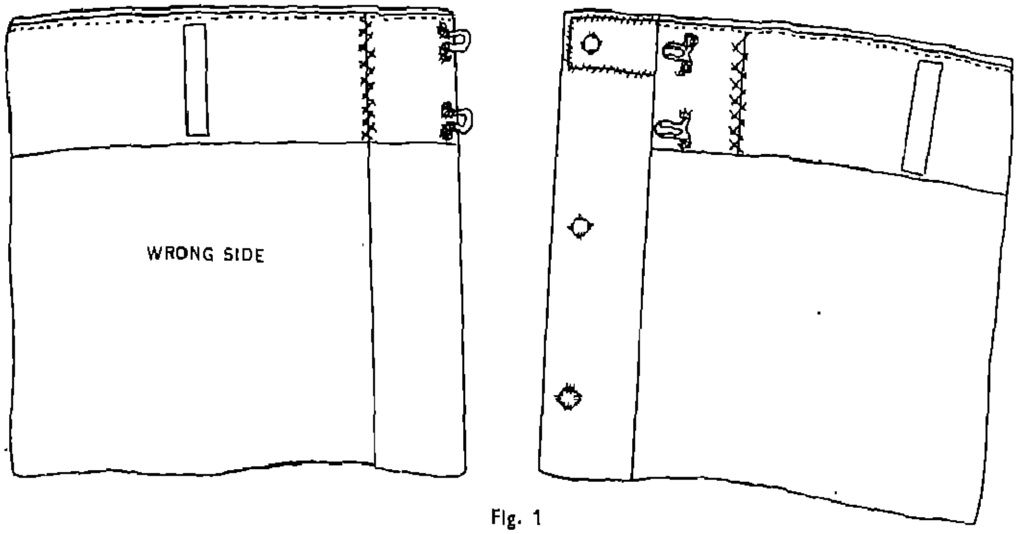


Fig. 1

7. Pin the band to the skirt, fasten the hooks and eyes, and fold at the centre front and centre back to make certain that the two seams are opposite each other and the two sides equal.

8. Tack the skirt and band together, try it on, and make any necessary adjustments as regards gathers, etc., afterwards machining carefully round the top of the band, Fig. 1.

9. Neaten the piece left free on the upper side of the opening with a piece of binding.

IV. TURNING THE HEM OF A SKIRT

Aim of lesson.—To teach the pupils how to give a skirt a neat appearance at the hem.

Arrangement of lesson.—As the teacher demonstrates, the girls work in pairs and carry out her instructions on each other's skirt.

Teacher's requirements.—A piece of material to represent a skirt; a tailor's square or long ruler; tailor's chalk; pins; coloured wool; needle; scissors; thimble; cardboard gauge; wide braid to represent paris binding; chart with illustrative sketches; skirts with hems neatened by the two methods.

Children's requirements.—A skirt; tailor's square or long ruler; tailor's chalk; pins; cotton; needle; scissors; thimble; cardboard gauge; paris binding.

DEMONSTRATION

1. Place the skirt on the wearer and let her stand upon a table. If the skirt is attached to a bodice lining, allow it to fall in its natural position before beginning to manipulate the hem.

2. Decide on the length of the skirt, and, using a tailor's square or a long ruler, mark with tailor's chalk or with a line of pins the turning-up line. This is done all round the skirt, the wearer turning slowly round during the process, Fig. 1.

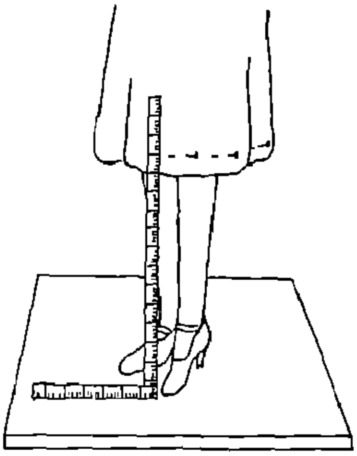


Fig. 1

3. Remove the skirt and tack-mark the pinned line.

4. Turn up the edge on the wrong side and tack the folded edge just below the turning-up line, Fig. 2.

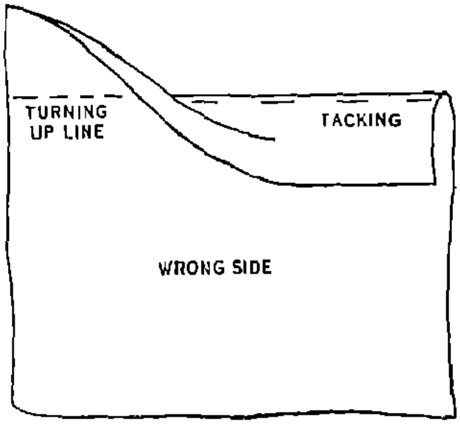


Fig. 2

If desired, instead of marking the turning-up line with tailor's chalk, turn up the edge of the skirt on the wrong side and pin along the folded edge, afterwards pinning up the turning. This method enables the wearer to obtain some idea of the appearance of the skirt when finished, and has that advantage over the method already described.

To neaten the turnings of the hem.—There are two methods of neatening the turnings of the hem. Method 1 is suitable for thin materials and Method 2 is suitable for thick materials.

METHOD 1

1. Turn the skirt the wrong side out.
2. Lay the skirt on the table, allow the hem to fall in its natural position, and measure the depth of the hem with a short cardboard measure or gauge, Fig. 3.
3. *Fold in the remaining material and pin* down, arranging the material in small pleats where any fullness occurs, Fig. 3.
4. Finish the hem by slip-hemming or machining, afterwards pressing well.

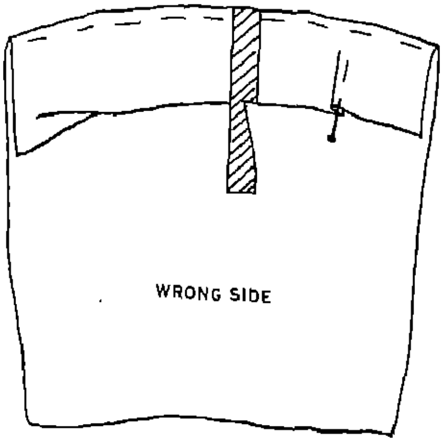


Fig. 3

METHOD 2

1. Proceed as for Method 1, and after measuring the depth of the hem tack paris binding through the hem only to the edge of the turnings, having the wrong side of the binding to the right side of the skirt and allowing the binding to project for half its width beyond the turnings, Fig. 4.
2. Machine the binding in position to the hem only.

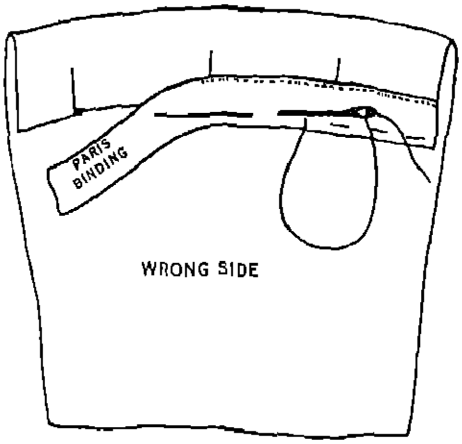


Fig. 4

3. Allow the other edge of the binding to fall in position on the skirt, tack and slip-hem or machine.

V. BOUND BUTTONHOLES

Aim of lesson.—To teach the best method of making a buttonhole on material that is apt to fray easily.

Arrangement of lesson.—The pupils work the processes along with the teacher as she demonstrates.

Teacher's requirements.—A piece of hessian; coloured wool; needle; scissors; thimble; chart showing the stages in the working of the buttonhole; garment showing the use of a bound buttonhole; easel.

Children's requirements.—A piece of material which will fray easily; cotton; needle; scissors; thimble; notebook.

Introduction.—When large buttonholes are required on a garment; e.g., a wrap-over skirt, Fig. 1, they are often bound with material if the material is very thick or thin and apt to fray easily, as by this method the edges of the buttonhole are firmer. They may be bound with the same material as the garment, or with a contrasting material to form a decoration.

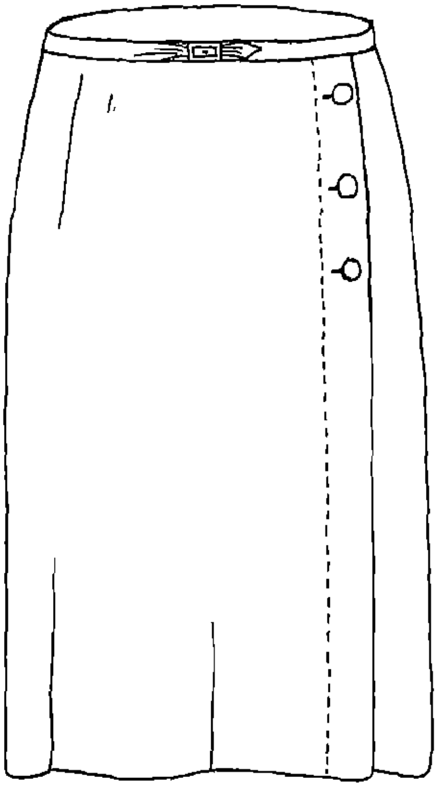


FIG. 1

DEMONSTRATION

1. Cut a strip of material selvedge way, about 2 in. wide and $1\frac{1}{2}$ in. to 2 in. longer than the buttonhole.

2. Mark the position of the buttonhole with a line of tacking stitches.

3. Place the strip of material evenly over the hole with the right sides facing. Tack it in position and tack-mark the position of the hole through the strip, Fig. 2.

4. Stitch round the tacking thread, keeping as close to it as possible, especially at the corners. On thin fabrics it is quite a simple matter to keep the line of stitching oval-shaped, Fig. 2, but with thicker materials the stitching may become rectangular in shape, Fig. 3.

5. Cut the buttonhole along the tacking line through both thicknesses of material. If necessary (i.e., when the stitching is rectangular), cut diagonally from the end of the buttonhole to each corner of the stitching, Fig. 3.

6. Take the strip through the hole to the wrong side, press it out flat, and tack all round the hole, Fig. 4A. In thick material allow a narrow margin of the binding to show on the right side, so that it forms a very close slit, Fig. 4B.

7. Turn in the raw edges, smoothing out any fullness at the ends, and hem to the upper layer of the material only, so that the stitches do not show on the right side of the garment, Figs. 4A and 4B.

8. If desired, a line of stitching may be worked close to the edge of the buttonhole, Figs. 5A and 5B.

BRIEF INSTRUCTIONS FOR THE CONTINUATION OF THE SKIRT

Computation of cost.—Kinds of material; widths; prices per yard; quantity required.

Cutting out.—Lay the front and back patterns to the fold of the material and cut out (allowing for pleats if necessary), allowing for turnings. For a flared skirt, open out the material to its full width, place one end of the pattern to the selvedge, cut out, then turn the pattern completely over and cut out a second portion, allowing for turnings in each case. Thread-mark the positions of any darts.

Making up the skirt.—If the skirt is attached to a bodice lining, cut out a bodice to reach $\frac{1}{2}$ in. below the waist. Join the shoulder and under-arm seams, and neaten the armhole and neck edges. If the skirt has pleats, tack the pleats in position first. These pleats may be arranged to face the side seams of the skirt or to form inverted pleats. Place the two portions of the skirt together with the right sides facing and,

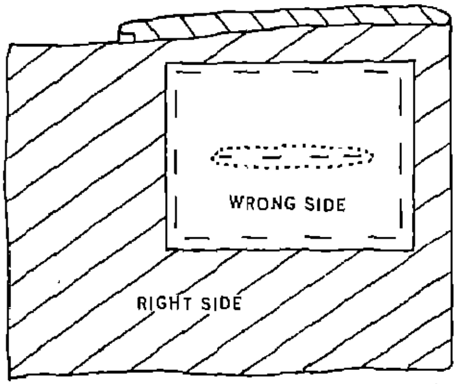


FIG. 2

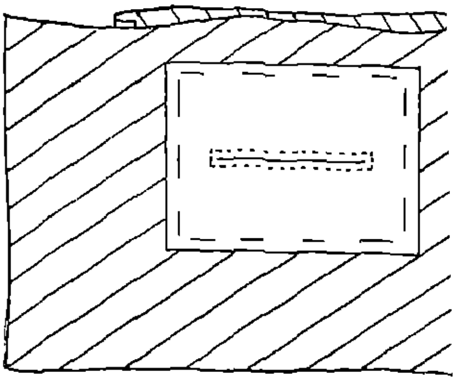


FIG. 3

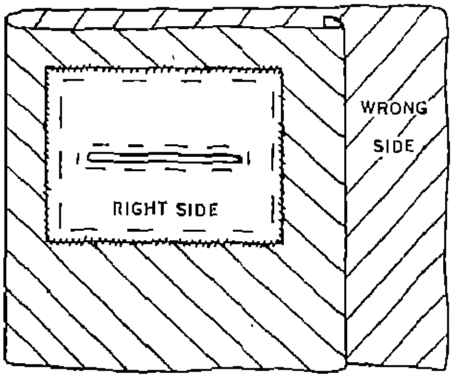


FIG. 4 A

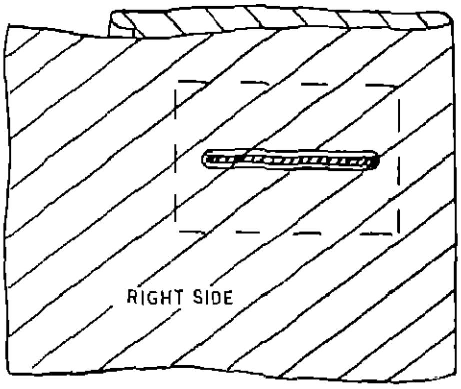


FIG. 4 B

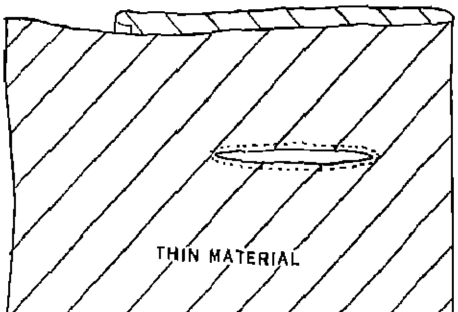


FIG. 5 A

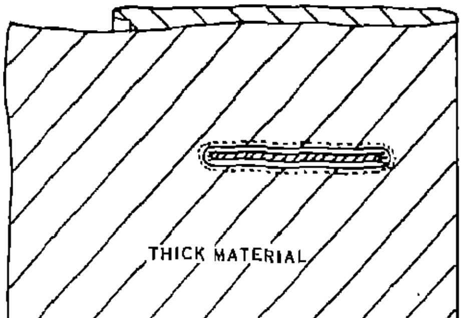


FIG. 5 B

beginning at the waist, pin and tack the edges together, afterwards machining them. Neaten the raw edges by overcasting and press the seams open. Machine, neaten and press the darts. Attach the skirt to the bodice lining if necessary. If supported by a petersham band, the left-hand side seam must be left open from the waist for about 10 in. to 12 in. to form a placket. Neaten the placket with a facing on the upper edge and a double extending piece on the under side. This opening needs careful handling so that (1) no sewing is visible on the outside, and (2) the line of the seam is kept when the placket is completed. Attach the petersham band. Mark the positions for the press studs, placing one at the top of the opening to keep flat the part of the skirt which is not attached to the band, and another right at the base of the opening as an added protection against the strain on the placket. Turn up the hem of the skirt and press flat. For a pleated skirt, machine each pleat down from the waist as far as desired, and press flat on the wrong side of the material. In a flared skirt, allow the skirt to hang for a day in order that the parts on the cross may have time to drop before arranging the bottom edge of the skirt. Cut the bottom edge even by measuring as before, and bind or face it with crossway strips of material, or turn a very narrow hem on the wrong side and machine.

VI. DECORATIVE STITCHERY

Aim of lesson.—The extension of the pupils' knowledge of decorative stitchery.

Arrangement of lesson.—The girls follow the teacher's instructions on a piece of crash as she demonstrates the working of each new stitch.

Teacher's requirements.—A large piece of crash; coloured wools; needle; scissors; thimble; charts showing the different stitches; chair-back covers illustrating the new stitchery; easel; drawing pins; pieces of coloured material.

Children's requirements.—A piece of crash; embroidery cottons or wools; needle; thimble; scissors; pieces of coloured linen; notebook.

DEMONSTRATION

Couching.—This is the tying down of one or more threads upon material by means of another thread. It is useful for solid fillings, for outline work, for edging applied work as in appliqué, etc. The simplest form of couching is to fix the threads in position by means of a single transverse stitch.

1. Place one or more threads on the material and pass another thread to and fro through the material over the laid threads, Fig. 1.

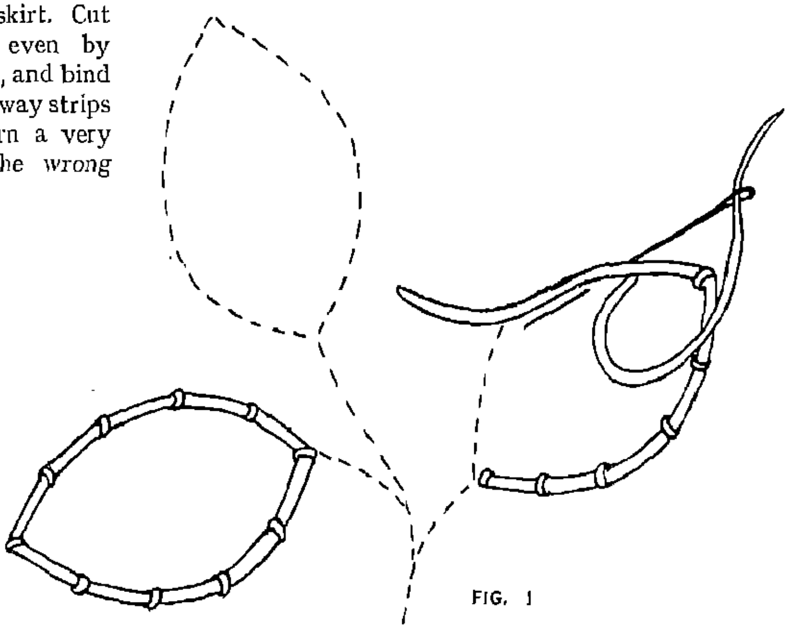


FIG. 1

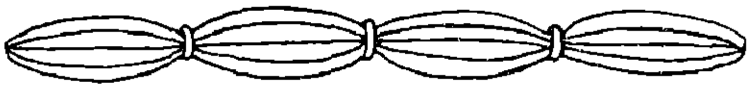


FIG. 2

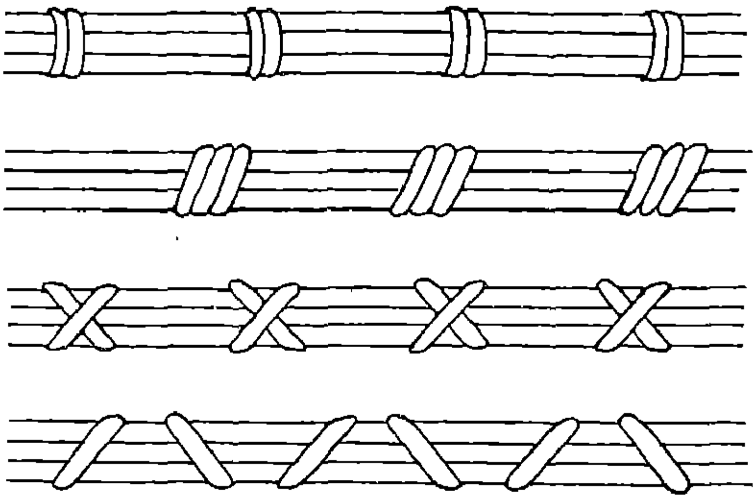


Fig. 3

2. When a number of threads are couched down together, if they are laid loosely on the material and the transverse stitch is pulled fairly tight, the result is a bunching of the laid threads between each fixed point, which looks singularly effective when carried out in different coloured threads, and especially so when worked with wools, Fig. 2.

3. The "fixing down thread" may occur at regular or irregular intervals, or it may be worked in the form of one of the patterns shown in Fig. 3.

Appliqué.—Appliqué is an important branch of decorative needlework, and its charm attracts every good needlewoman. It is a fancy form of the old-fashioned patchwork and, like patchwork, requires designs with large surfaces, hence the suitability of free-cutting designs. The methods of working appliqué are varied, the following methods being the simplest.

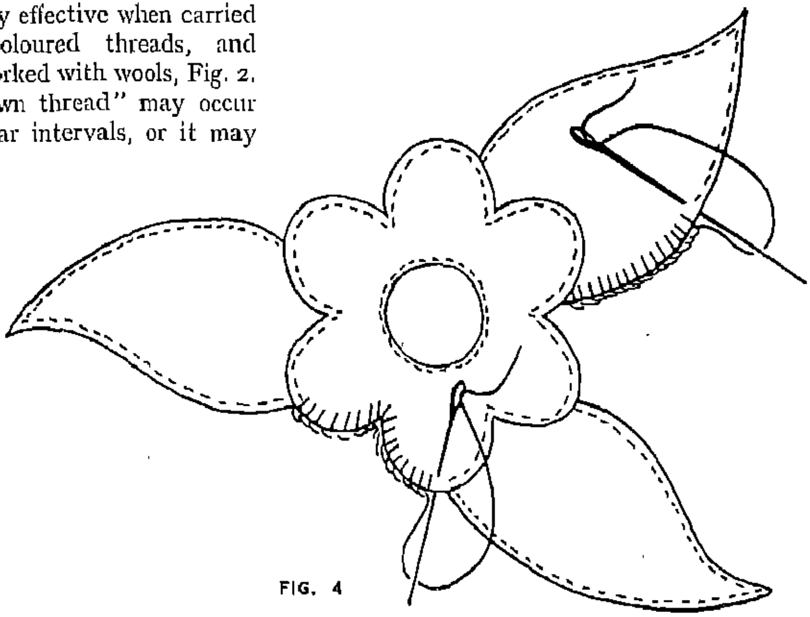


FIG. 4

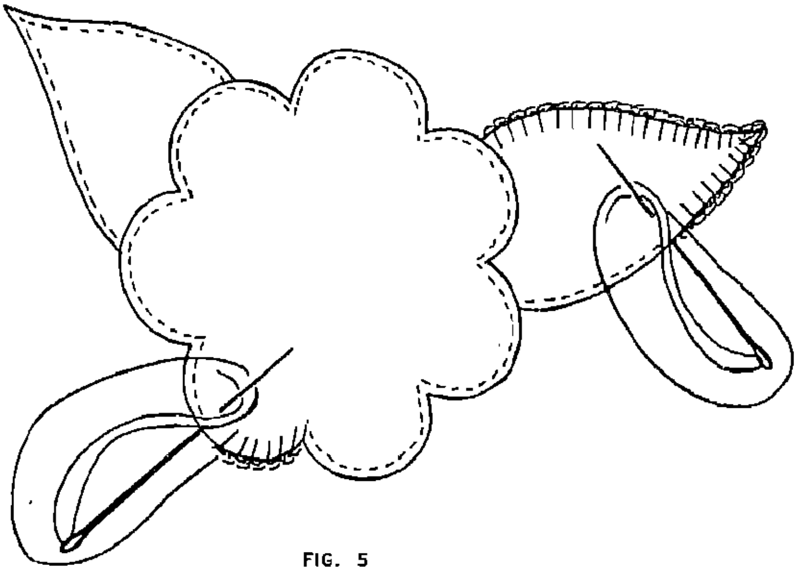


FIG. 5

1. Cut out a *motif* in coloured linen and lay it in position on the material.

2. Hold it in position by means of a row of small running stitches placed near the edge.

3. Cover these stitches and the raw edges by (*a*) blanket stitches worked closely together, Fig. 4; (*b*) buttonhole stitches worked closely together, Fig. 5; or (*c*) close satin stitch over a thread placed along the edge, Fig. 6.

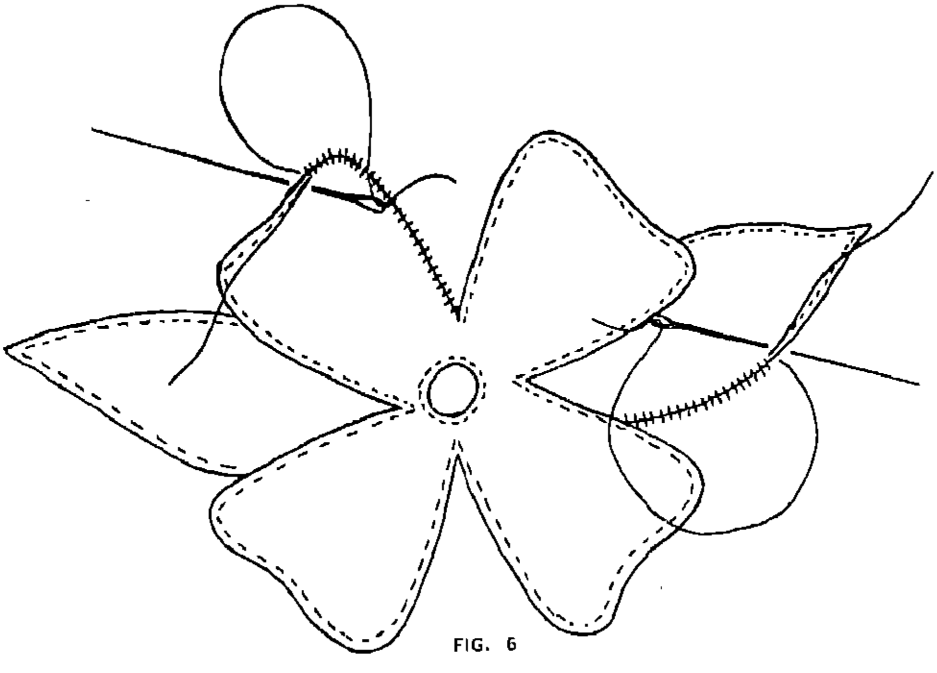


FIG. 6

BRIEF INSTRUCTIONS FOR MAKING CHAIR-BACK COVERS

Cut out two chair-back covers and one settee cover according to the size required. Turn hems on all edges, three narrow and one broad hem along the bottom of the cover, and hold them in position with any suitable border stitch already learnt.

The decoration of the covers may take the form of a centre piece, two triangular corners, or a straight border worked at the end of the cover where the broad hem lies. Fig. 1 shows a suggested design for a centre piece in which the leaves and some of the flowers are carried out in appliqué, and the stems couched. In Fig. 2 the decoration is for a triangular corner worked in couching. Figs. 3 and 4 suggest a corner and centre piece which would look most attractive if worked in appliqué, using different coloured linens for the leaves and flowers. For a border design in which couching or appliqué could be suitably introduced, Fig. 5 is a suggestion.

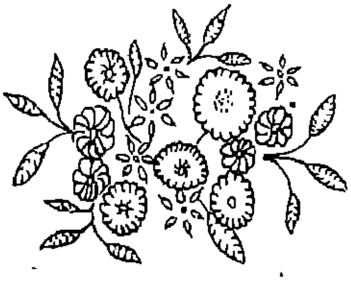


FIG. 1

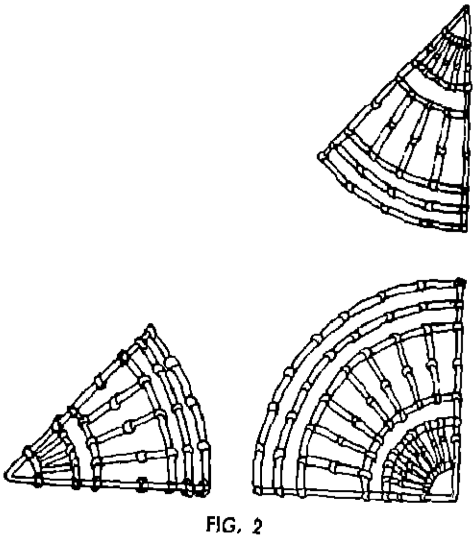


FIG. 2

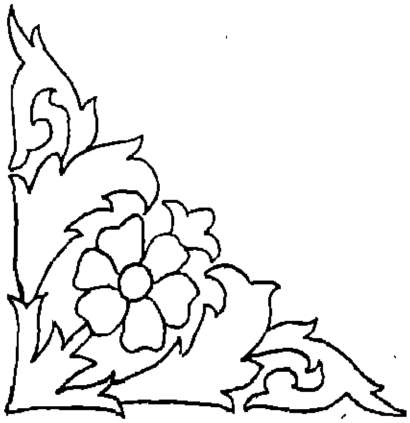


FIG. 3

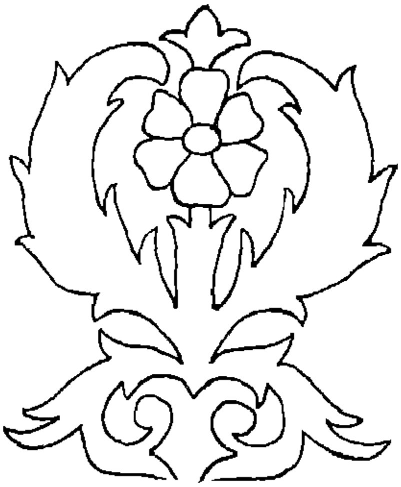


FIG. 4

VII. REPAIR WORK

Aim of lesson.—To teach the pupils economy by making use of worn articles.

Arrangement of lesson.—The girls carry out the teacher's suggestions on the old household linen they have brought.

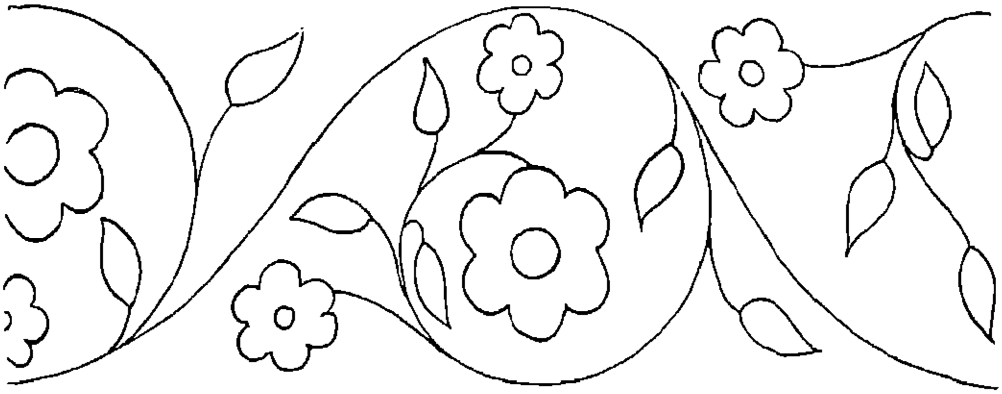


FIG. 5

Teacher's requirements.—Old household linens; renovations made from old linen; scissors; blackboard containing notes.

Children's requirements.—Old household linen; scissors; notebook.

Care of household linen.—All articles in use for domestic purposes are classed under the heading "Household Linen," whether they are made of linen, damask, or cotton. These should be stored in a cupboard kept in a dry place to prevent mildew. Each set of articles should be kept in its own particular place to avoid unnecessary handling. All articles must be examined before washing, and patched or darned to prevent the tears enlarging. They should be again examined after washing, mended if necessary, and aired well before storing in the cupboard. The cupboard should be cleaned periodically to remove all fluff, etc., and the shelves covered with clean paper.

DEMONSTRATION
Uses of old Household Linen

Sheets.—A good renovation may be made with old sheets. They usually wear out in the centre and their life may be lengthened considerably if they are cut up the centre and the sides turned into the middle.

1. Place the selvedges together and sew them on the right side, afterwards flattening the seam.
2. Cut away all the worn material from the "new" sides in straight even lines and fix narrow hems.

Sheets too much worn to be treated in this manner may have their good parts utilised by being made into undercoverings for pillows and bolsters.

Blankets.—These may be made into smaller blankets for a cot. Blanket-stitch all new edges to prevent ravelling. Smaller pieces may be saved for hot fomentation cloths for use in the sick room, and old pieces will serve as good floor cloths or polishing cloths.

Damask.—When tablecloths are beyond repair, cut out the best parts and make them into table napkins by turning narrow hems on all raw edges. Smaller portions may be used for the centres of d'oyleys.

Worn calico articles.—These may be cut up and used as dusters. Several pieces joined together provide good dust sheets, and long narrow strips serve admirably for bandaging wounds.

Muslin.—Good portions of worn out muslin articles should be kept for straining purposes.

THIRD YEAR COURSE—SECOND TERM

Pattern making.—Jumper pattern from the adaptation of the bodice block.

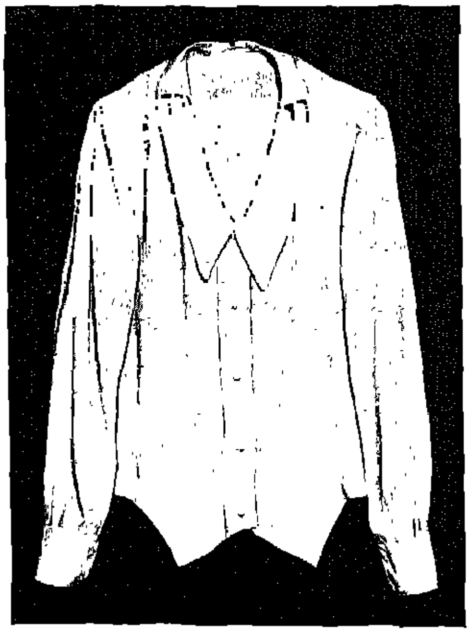
Garment or article to be made.—Jumper or blouse; chair-back covers.

Knitting.—Bathing suit.

Processes.—Adaptation of bought patterns; *neatening* a *neck* line.

Decorative stitchery.—Application of the stitches learnt in previous terms.

Repair work.—Adaptation and renovation of worn garments.



JUMPER SHOWING ROULEAU WORK ON THE COLLAR, NOT JOINED BY FAGGOTING

Discussion of work.—Several blouses and jumpers of varying styles, as in Figs. 1, 2, 3, and 4, should be displayed and attention drawn to their respective differences; e.g., the neck line; the length of the sleeve; the waistline, etc. Reference should be made to the processes involved in the making of

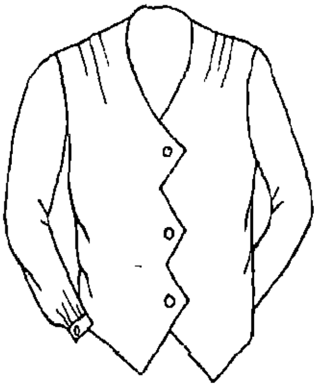


FIG. 1

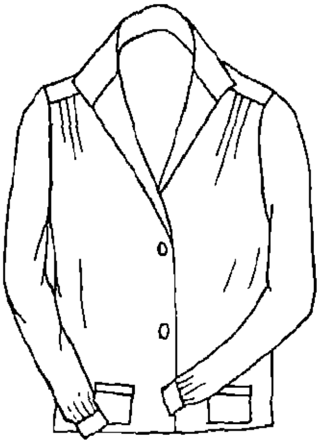


FIG. 2

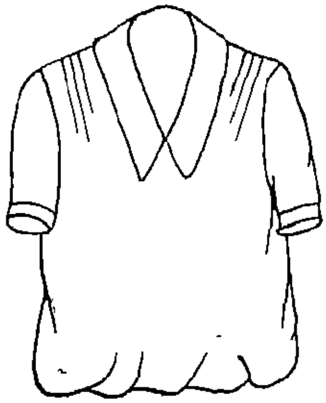


FIG. 3

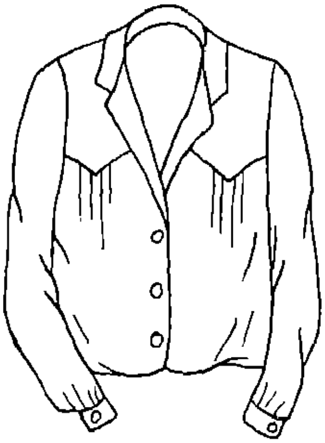


FIG. 4

these garments which will be dealt with during the term.

The decorative articles, along with the knitted article, should be on view for reference purposes, and any difficulty likely to arise should be explained.

As many renovated garments as possible should be exhibited, and the economical value of the repair work pointed out.

I. DRAFTING THE JUMPER PATTERN

Arrangement of lesson.—As the teacher demonstrates the drafting of the pattern, the pupils work along with her step by step.

Teacher's requirements.—A large sheet of drafting paper; coloured pencils; bodice block pattern; blackboard illustrating the new draft; spare blackboard; a drafted pattern; ruler; tape measure; drawing pins; a finished garment; scissors.

Children's requirements.—A sheet of drafting paper; pencil; ruler; tape measure; scissors; bodice block; notebook.

Introduction. — Blouse making depends upon the prevailing fashions. These vary considerably, but the simple shirt blouse already described provides a good standard pattern which is always useful, for many different styles may be obtained from it. It is always fashionable (with slight modifications) because of its usefulness and neat appearance. A jumper blouse is one which is passed over the head instead of being put on like a coat. In such a case the neck line is cut low enough to present no difficulty when slipping the jumper on over the head, or an opening is made down the front and finished decoratively. It is made longer than a blouse, varying in lengths between the waistline and the hip line. Blouses or jumpers may be of the tunic or tuck-in types, with short or long sleeves, round or V-shaped necks neatened with a facing or binding, or with a collar with or without revers.

DEMONSTRATION

Using the bodice block, make the following alterations to allow the jumper to fit with ease over the hips.

1. Extend the centre back and front lines at A and D respectively to the required length. Draw horizontal lines from E and F.

2. Find the difference between half the bust measure plus 1 in. (i.e., AB + CD), and half the hip measure plus 1 in. EG = AB plus half the difference. FH = DC plus half the difference. Join LG and MH with straight lines, afterwards curving $\frac{1}{2}$ in. at the waist, Figs. 1A and 1B.

3. Lower the centre front line 1 in. and

slightly curve the bottom line into the under-arm line from P.

4. Extend the centre front line as desired for a blouse or tunic with a wrap-over front, Q.
5. Lower the neck line if necessary.
6. For a Vandyked wrap and bottom edge alter as R, Fig. 1B.

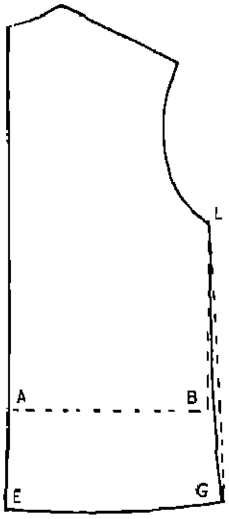


FIG. 1A

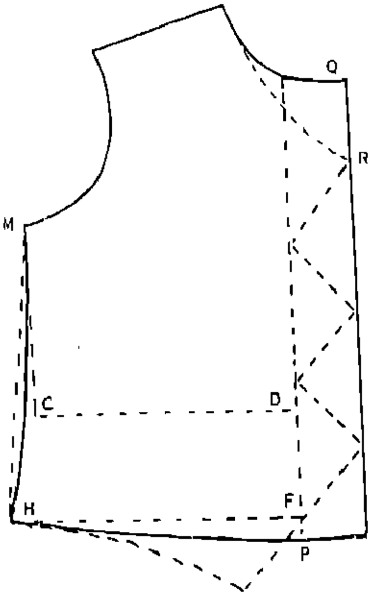


FIG. 1B

II. USE AND ADAPTATION OF BOUGHT PAPER PATTERNS

Aim of lesson.—To teach the pupils how to adjust a bought paper pattern to fit their own figure.

Arrangement of lesson.—Following the teacher's instructions, the girls make their own necessary adjustments.

Teacher's requirements.—Bought and drafted patterns of a Magyar dress, bodice, sleeve, skirt, knickers; scissors; chart showing the methods of altering the patterns.

Children's requirements.—Bought and drafted patterns of a Magyar dress, bodice, sleeve, skirt, knickers; scissors; notebook.

Introduction.—If a comparison of the two kinds of pattern is made, then the girls will readily see which part of the bought pattern requires adjustment to fit their figure. If a record of these adjustments is kept in their notebook, it is always there for future reference.

DEMONSTRATION

A Magyar dress pattern.—

1. Cut or tuck the full length from hem to hem when altering the width, Figs. 1A and 1B. This will lengthen or shorten the sleeve, which must be altered accordingly.
2. Cut or tuck the under-arm seam to lengthen or shorten respectively, Figs. 2A and 2B.

Bodice.—

1. To keep the proportion of the pattern when the length needs altering, cut or tuck equally on the armhole and under-arm line. (The sleeve must be altered accordingly.) If the garment is intended for a particularly long-waisted or short-waisted person, the alteration must be made on the under-arm only.

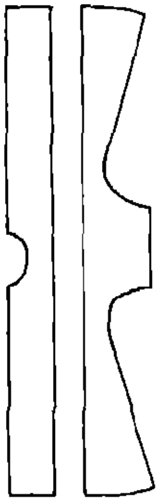


FIG. 1 A

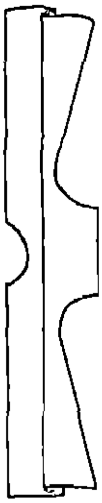


FIG. 1 B

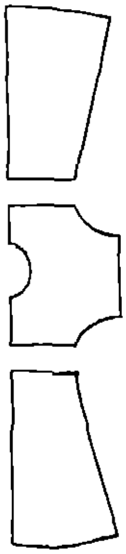


FIG. 2 A

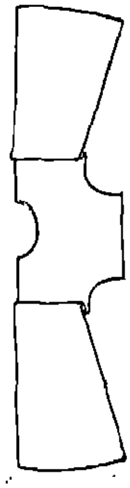


FIG. 2 B

2. To alter the width, cut or tuck down the length, making rather more than half on the front pattern and the remainder on the back pattern.

3. To raise or lower the shoulder line, alter as in Figs. 3 and 4. For a square shoulder cut the shaded portion, raise it, and draw the altered shoulder line and armhole curve, Fig. 3.

4. Similarly, cut and lower for a sloping shoulder, Fig. 4.

5. For a long shoulder, extend the shaded portion as in Fig. 5.

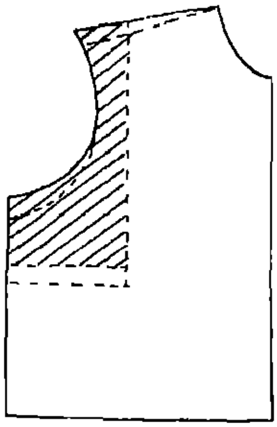


FIG. 3

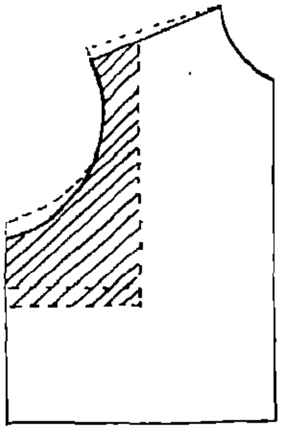


FIG. 4

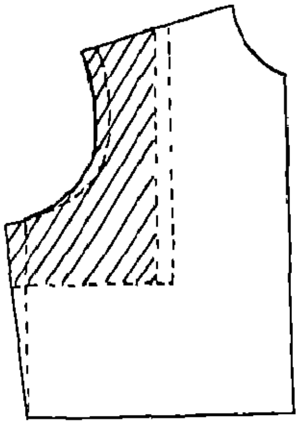


FIG. 5

Sleeves.—If the alteration is small, make it at the edges only, otherwise cut or tuck as in Figs. 6A to 8B.

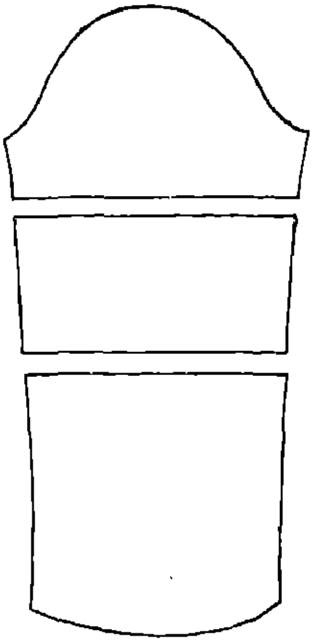


FIG 6 A

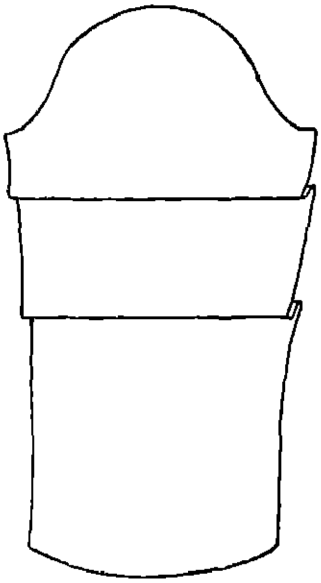


FIG. 6 B

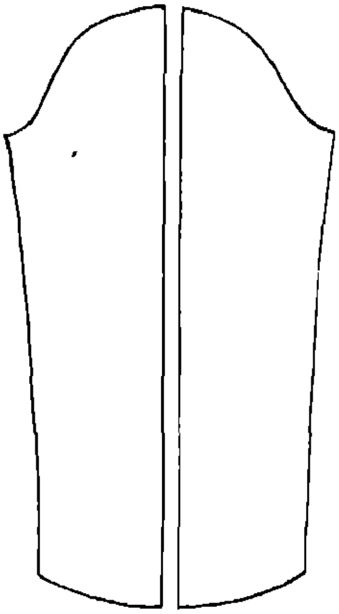


FIG. 7 A

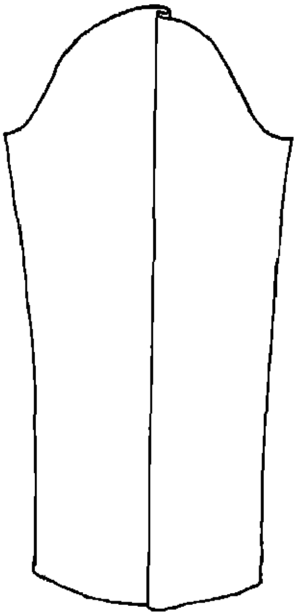


FIG. 7 B

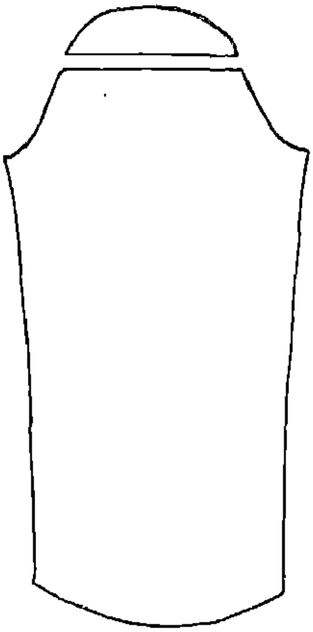


FIG. 8 A

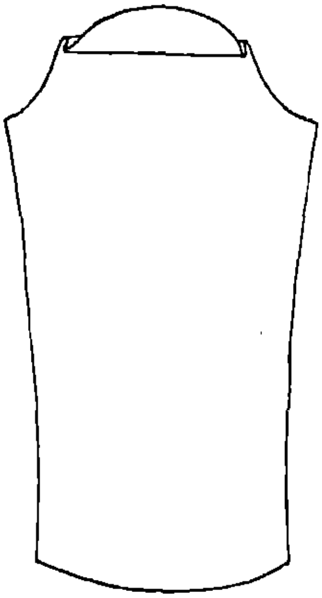


FIG. 8 B

Skirts.—

1. To alter the length, cut or tuck across each portion of the pattern as in Figs. 9 and 10.

2. For the width, alter on the side seam of the front pattern and the centre back, Figs. 11 and 12.

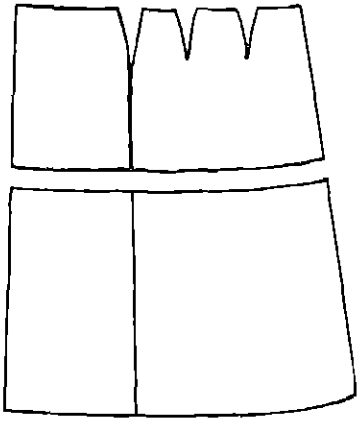


FIG 9

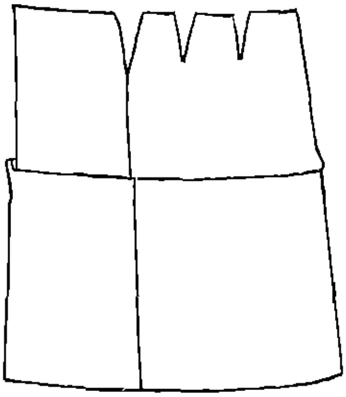


FIG. 10

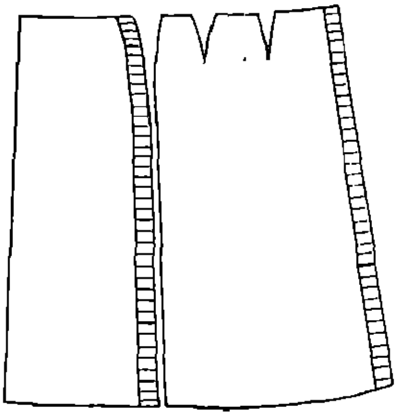


FIG 11

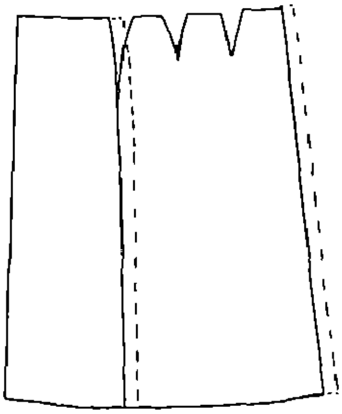


FIG 12

Knickers.—

1. When altering the knicker pattern in length, put two-thirds in the seat and one-third in the legs, Figs. 13 and 14.
2. For the width, alter as in Figs. 15 and 16.

III. NEATENING A NECK LINE

Aim of lesson.— To teach the pupils how to give a neck line a neat appearance whatever the style chosen.

Arrangement of lesson.—The pupils follow the teacher's demonstration, working on their own material, which will afterwards be kept as samplers.

Teacher's requirements.—Pieces of material cut to represent a V-shaped neck line and a square neck line; straight pieces and crossway strips of material; coloured wool; needle; scissors; pins; thimble; jumpers showing neck lines of different shapes; chart with sketches illustrating the stages in neatening the neck line.

Children's requirements.—Pieces of material cut to represent neck lines of different shapes; straight pieces and crossway strips

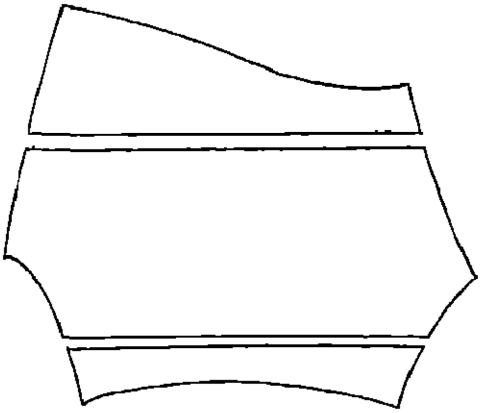


FIG. 13

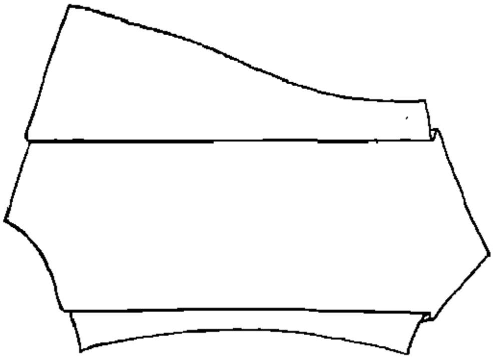


FIG. 14

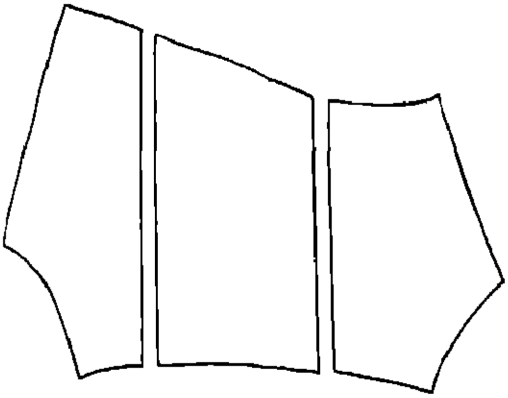


FIG. 15

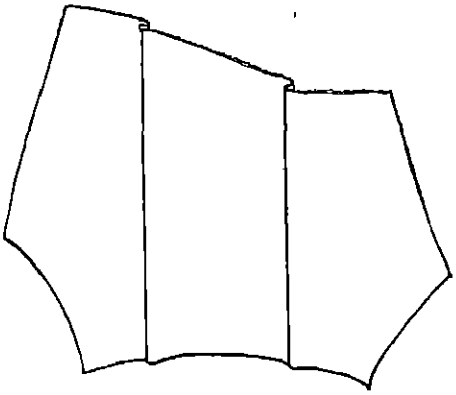


FIG. 16

of material; pins; cotton; needle; scissors; thimble; notebook.

DEMONSTRATION

To neaten a V-shaped neck line.—This may be done in one of two ways.

1. Face the neck line with a shaped piece. When cutting this piece out, great care must be taken to obtain the pattern of the neck line. Fold the jumper carefully down the centre front, place to the fold of the material, and allow the neck line to take its own natural course, to ensure a perfect fitting shaped piece.

2. Face the neck line with the crossway strips of material, mitring the base of the "V."

To neaten a square neck line.—This may be done in one of three ways.

1. *Faced with a shaped piece.*—

(*a*) Cut the pattern of the shape of the neck line and measure the desired width of the facing plus turnings. (1½ in. will give a 1 in. facing.)

(*b*) Place the facing in position, edge to edge, with the right side of the facing to the wrong side of the garment. Pin, tack, and machine ¼ in. in from the edge, Fig. 1.

(*c*) Snip each corner diagonally almost to the stitching and remove the tacking threads, Fig. 1.

(*d*) Turn over the facing to the right side, and tack round the neck line with the facing projecting slightly.

(*e*) Turn under the raw edge, tack, and then machine, Fig. 2.

2. *A shaped facing with a join on the shoulder.*—The method just described cuts into rather a large amount of material. If the material is scanty, cut the shaped facing with a join on the shoulder from the waste pieces of material. Join the seams, press, and proceed as in the previous method.

3. *Neatening with four straight strips.*—

(*a*) Cut four strips of material 1½ in. wide; two 2 in. longer than the width of the neck for the front and back, and two 2 in. longer than the length of the neck line over the shoulder.

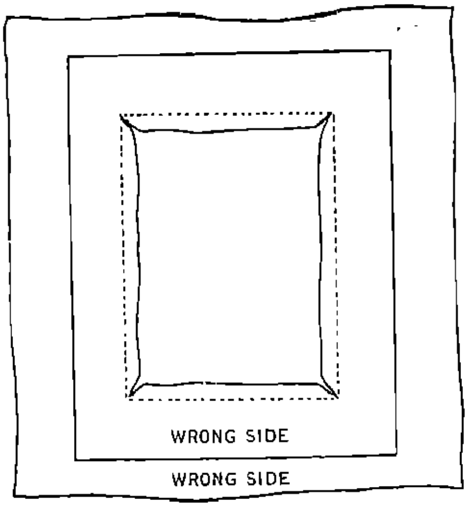


FIG. 1

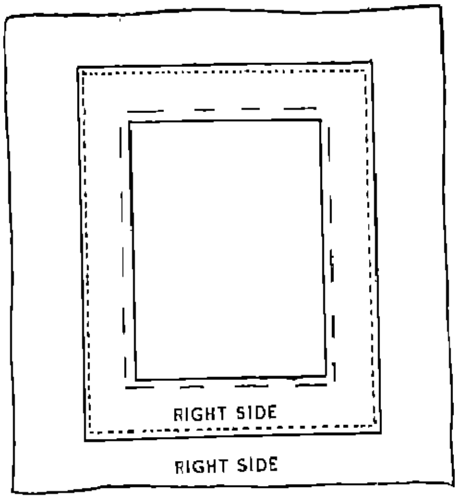


FIG. 2

(*b*) Snip each corner of the neck diagonally slightly less than ¼ in.

(*c*) Place the two strips for the front and back neck in position on the wrong side of the garment, tack and machine ¼ in. away from the edge just the length of the neck only, Fig. 3.

(*d*) Remove the tacking threads, turn over to the right side, tack round the neck line, turn under the raw edges and tack, Fig. 4.

(*e*) Arrange the two strips over the shoulder in the same way (Fig. 4), afterwards forming the mitred corners, Fig. 5. Machine all the edges.

(*f*) If desired, the strips may be arranged as in Fig. 6. In this case, cut the front and back strips ½ in. longer than the neck line, and the shoulder strips long enough to overlap the horizontal strips.

BRIEF INSTRUCTIONS FOR THE CONTINUATION OF THE JUMPER

Computation of cost.—Kinds of material; widths; prices per yard; quantity required.

Cutting out.—When cutting out the front and back, allow for any gathers, tucks or darts on the shoulder, and turnings on all edges. Cut out the sleeves, facings, cuffs and collar.

Making up.—Proceed in the same manner as for the gym blouse. If any facings are added as decorations, rows of machine stitching enhance their appearance. Neaten the neck line. If a tuck-in blouse is required, turn a ½ in. hem along the bottom edge and insert elastic to fit the waist measurement.

IV. REPAIR WORK

Aim of lesson.—To teach the pupils how to make old garments into "new" ones.

Arrangement of lesson.—Using their own worn garments, the pupils renovate them according to the methods given in the teacher's demonstration.

Teacher's requirements.—Worn garments of every description; e.g., petticoats, dresses, stockings, etc.; scissors; sketches on the blackboard to show the stages in any renovation wherever possible; "new" garments made from old ones; pins; coloured wool; needle; thimble.

Children's requirements.—Worn garments; scissors; cotton; needle; thimble; pins.

Introduction.—Much-worn garments may very often be adapted to form other garments. Many frequently contain much material that is good, and with careful manipulation this good material may be utilised in making useful garments for younger children.

DEMONSTRATION

1. Cut up a petticoat to form a pair of knickers for a younger child.
2. Turn dresses worn under the arms into petticoats or smaller dresses.
3. Cut old woollen stockings into neat little jerseys for the small boy.
4. Cover soft toys for baby with old woollen stockings.
5. Alter woollen jumpers worn at the elbows to form useful sleeveless jumpers or cardigans by binding the edges with silk braid to tone with the jumper.

Renovating the hem of a skirt.—In many cases skirts or dresses which are in constant wear become worn along the folded portion of the hem. The life of the garment may be prolonged by the application of a "false hem." This may be made with the material from the old hem if it is in thin fabric, and in such a case the depth of the hem is lessened. When the material is of thick

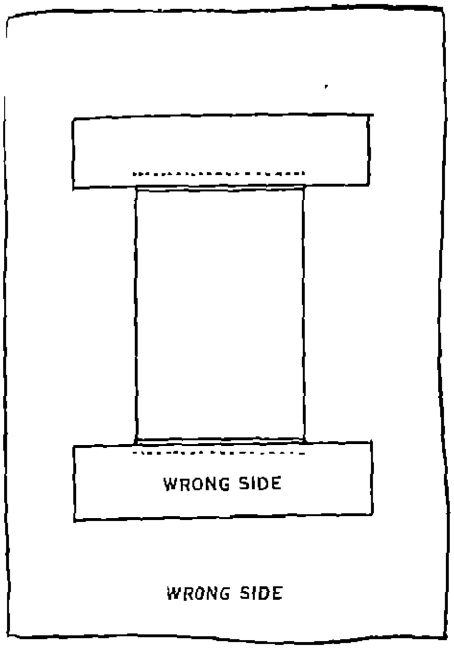


FIG. 3

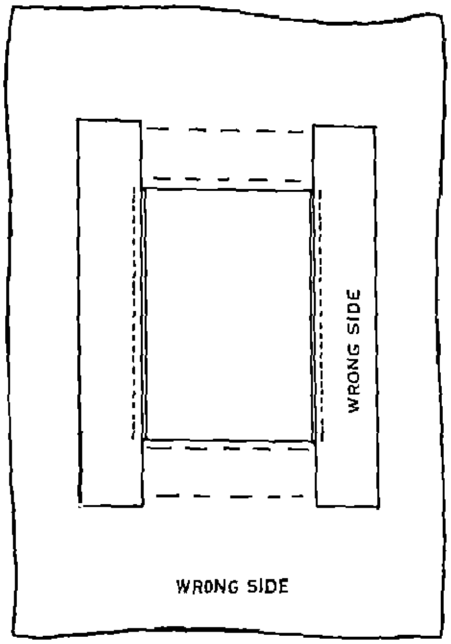


FIG. 4

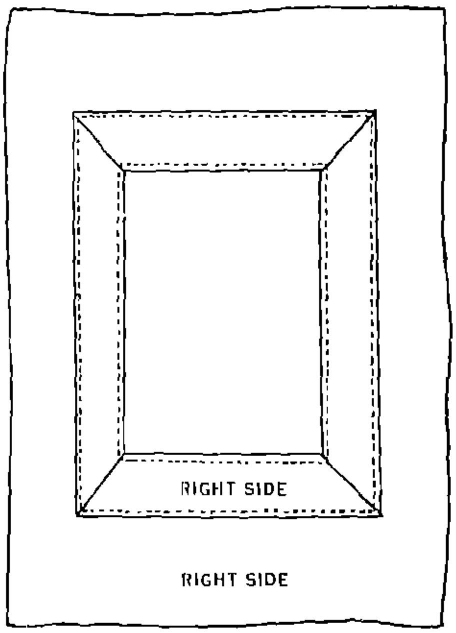


FIG. 5

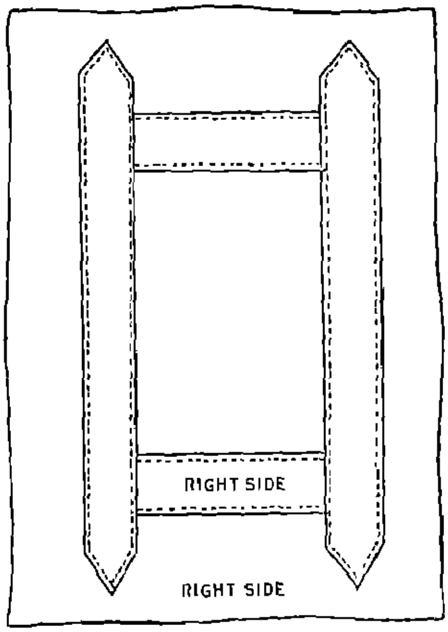


FIG. 6

texture it is better to make the new hem of a fine durable material, such as sateen, to avoid bulkiness at the join, and by this method the original depth of the hem is maintained.

1. Unpick the hem, and cut along the worn fold.

2. Fold the skirt down the centre back and front, and place the sateen, folded with the wrong side outside as in Fig. 1.

3. Mark along the bottom edge of the skirt on the sateen, and also down each side to the depth of the hem required plus 1 in. turning, Fig. 1.

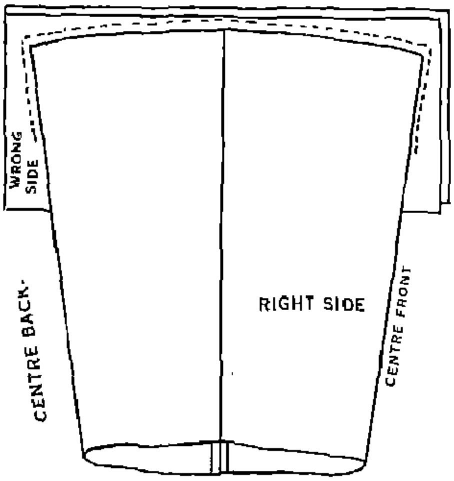


FIG. 1

4. Remove the skirt and mark the depth of the hem plus 1 in. turnings.

5. Cut out through the double material, leaving ½ in. turnings at the side only.

6. Stitch up the sides and press the seam flat.

7. Place the right side of the sateen to the right side of the skirt, with the joins to the centre back and front, and machine ½ in. from the edge, Fig. 2.

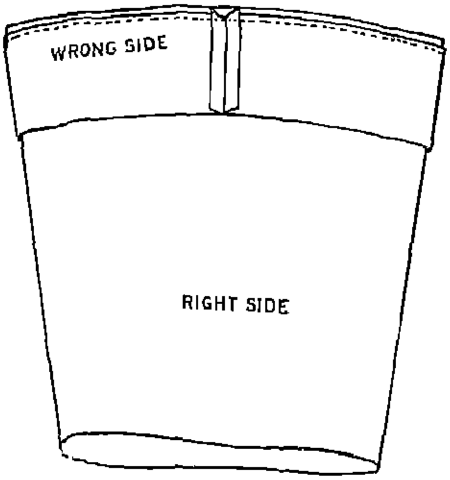


FIG. 2

8. Turn over the hem to the wrong side of the skirt and tack along the joined portion, having the skirt showing slightly above the sateen on the wrong side, Fig. 3.

9. Snip the turnings of the hem if necessary, turn under, and slip-stitch to the skirt, Fig. 3.

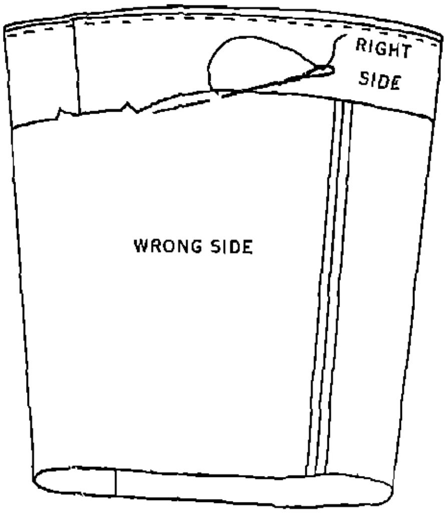


FIG. 3

Renovating a cuff worn at the edge.—

Cut through the worn edge of the cuff, turn the raw edges inside to face each other, and machine both edges together close to the edge. This will make the cuff slightly narrower. If the cuff must not be made any narrower, then the old cuff must be removed and a new one set on.

Renovating a worn band.—When the fastening on a band has become too tight, the strain on the buttonhole becomes so great that the fastening tears. When this happens, unpick the ends of the band for 2 to 3 in., cut off the worn parts and replace them with new and longer pieces, joining them to the old bands by single seams. Set the garment into the band again, spreading out the gathers a little into the new portion, and make new fastenings, Fig. 4.

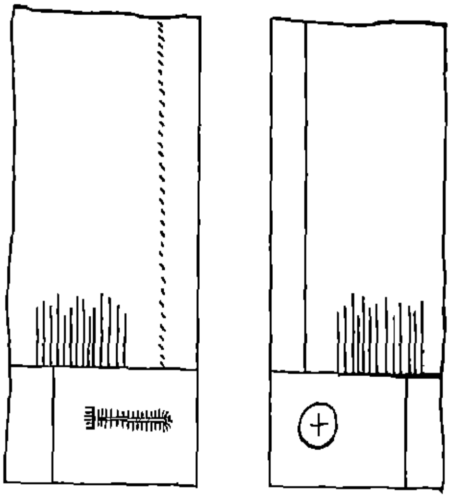


FIG. 4

THIRD YEAR COURSE–THIRD TERM

Pattern making.—Dress.

Garment or article to be made.—Simple dress; chair-back covers; cushion covers.

Knitting.—Bathing suit.

Processes.—Hem-stitching; rouleau work.

Decorative stitchery.—Application of the stitches learnt in previous terms.

Repair work.—Repairing gloves.

Discussion of work.—No lesson is required on the drafting of the dress pattern, as it is formed by combining the jumper and skirt patterns. One or two styles of dress should be exhibited with flared and pleated skirts, as in Figs. 1 and 2.

The chair-back covers should again be displayed for reference purposes, as also one or two cushion covers, which will serve as suggestions for the making and the decoration of another household article if time permits.

The pupils' knitted article should be nearing completion, and stress must be placed on the necessity for a good general finish of the garment.

The repairing of gloves will provide a fitting ending to the course, as in many cases this article of apparel is very conspicuous in its neglect. Gloves well repaired prove the qualities of a good needlewoman.

I. HEM-STITCHING

Aim of lesson.—To teach the pupils how to make a decorative hem.

Arrangement of lesson.—The pupils work along with the teacher as she demonstrates each process.

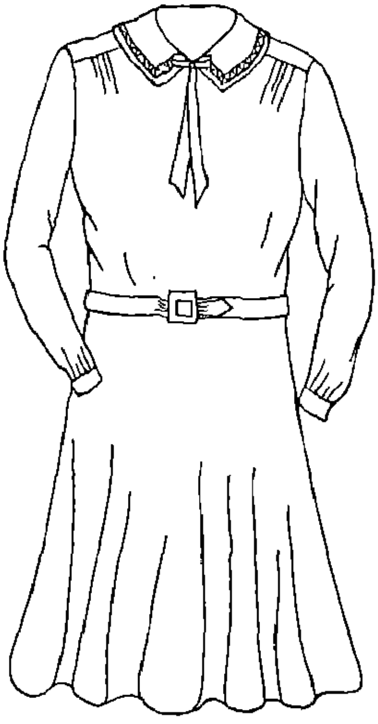


FIG. 1

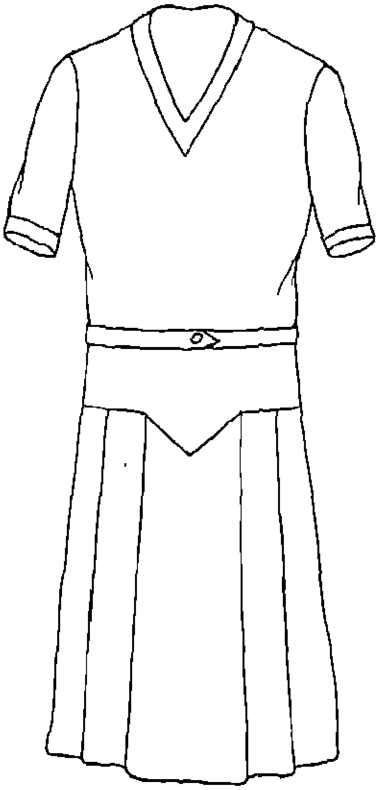


FIG. 2

Teacher's requirements.—A piece of crash; coloured wools; needle; scissors; petticoat with hem-stitched top; cushion cover with hem-stitched border; blackboard or chart showing sketches of the working of the stitch; thimble.

Children's requirements.—A piece of crash; scissors; embroidery cottons; needle; thimble; notebook.

Introduction.—Hem-stitching is a very useful stitch for decorative purposes, as it forms an open-work border along the inner edge of a hem. There are two simple methods of working the stitch.

DEMONSTRATION

METHOD 1

1. Turn down the hem, even to a thread, and tack.

2. Draw a few threads from the material as close to the hem as possible and parallel with it. The number of threads drawn varies according to the texture of the material.

3. Begin securely with the thread as for ordinary hemming.

4. Insert the needle immediately below the point where the cotton was drawn out on the hem, and lift up a few threads on the needle horizontally. (Any number of threads may be taken, four, five or six, according to

the thickness of the material.) Draw the needle through, Fig. 1.

5. Insert the needle in the same place as at first (as for a back stitch), and make an ordinary hemming stitch on the edge of the fold (Fig. 2) and continue working this stitch.

METHOD 2

1. Hold the work as for blanket stitching, with the hem towards the worker, and with the material stretched over the fingers.

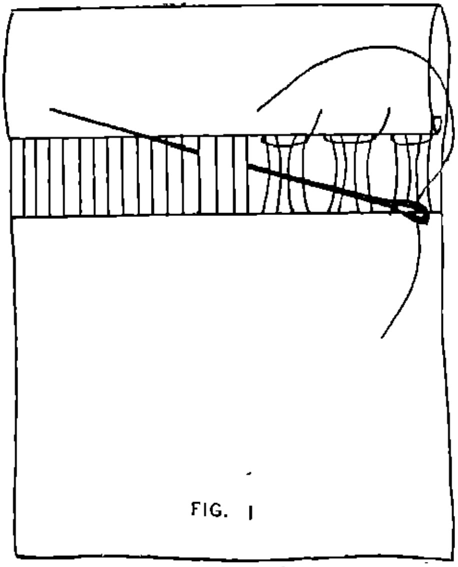


FIG. 1

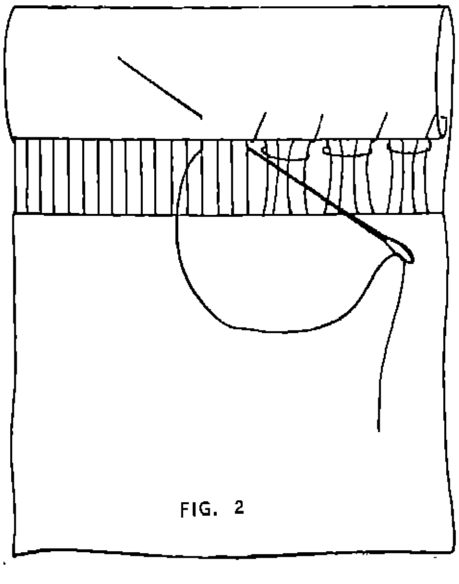


FIG. 2

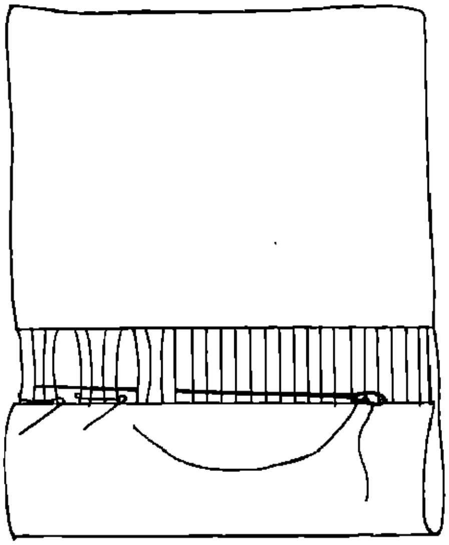


FIG. 3

2. Begin as for ordinary hemming.

3. Insert the needle as in Method 1. Lift up the required number of threads, bringing the needle out over the sewing cotton, which is held down with the thumb as in blanket stitching, Fig. 3.

4. Make a vertical stitch into the hem, Fig. 4. Continue working this stitch.

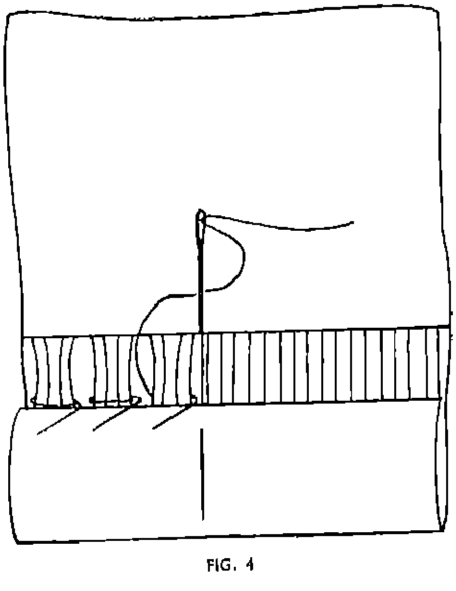


FIG. 4

II. ROULEAU WORK

Aim of lesson.—To teach the pupils how to make an effective trimming on a jumper or dress.

Arrangement of lesson.—The pupils work along with the teacher as she demonstrates each process.

Teacher's requirements.—A piece of material to represent a collar; several crossway strips of material; a piece of drafting paper; coloured wools; needle; scissors; thimble; jumper or dress decorated with rouleau work; chart showing the different methods of fixing the strips.

Children's requirements.—A piece of material to represent a collar; several crossway strips of material about $\frac{3}{4}$ in. wide; cotton; needle; scissors; thimble; embroidery cottons; notebook.

Introduction.—Rouleau work is a very effective way of decorating a dress. Rouleaux may be inserted in the material or used as a border for the edge of a collar, etc.

DEMONSTRATION

1. Join all the crossway strips to form one long length, fold it lengthways and machine the long edges together to form a tube of material $\frac{1}{4}$ in. wide.
2. Turn the tubular strip inside out with the aid of a bodkin, tack the joined edge to keep the seam flat, and press with an iron.
3. Prepare the collar (or material) by tacking the edge to a strip of paper. (If the material is single, the edge must first be neatened as in faggoting.)
4. Place the rouleaux in position on the paper as in Fig. 1, and tack.
5. The pattern formed by the twisted rouleaux may form the edge of the collar, or another rouleau may be placed along the outside edge in a straight line (Fig. 2), or mitred to take the shape of the pattern as in Fig. 3.

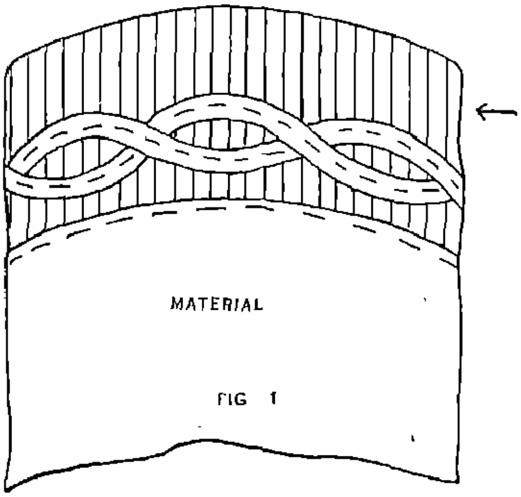


FIG 1

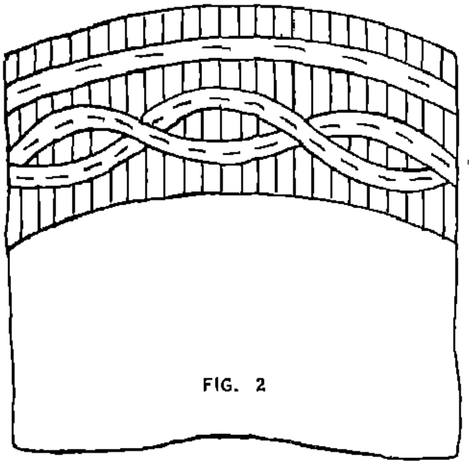


FIG. 2

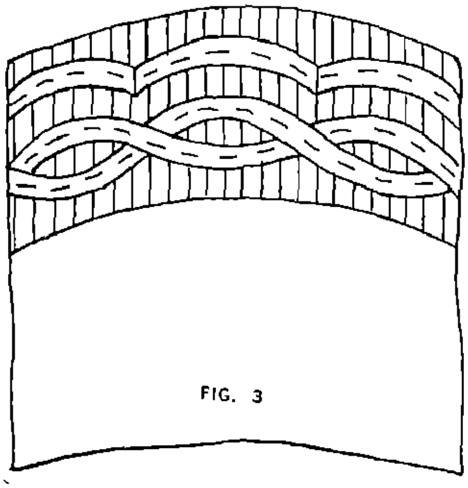


FIG. 3

6. Attach the rouleaux to the garment by means of faggot stitching.

7. Remove all the tacking threads and the paper.

If desired, the rouleaux may be placed in position on the paper to form lines parallel to the edge of the collar instead of forming a twist.

BRIEF INSTRUCTIONS FOR MAKING UP THE DRESS

Cut out the bodice portion as for a jumper or blouse, allowing for any extra fullness according to the style chosen. Cut out the skirt required, allowing for pleats if necessary. Make up the blouse portion as for the jumper or gym blouse; make up the skirt according to instructions, and join the blouse portion and skirt portion together either at the waist or below the waist, as desired. Decorate the collar or neck line with rouleau work if desired. Finish the dress with a belt.

BRIEF INSTRUCTIONS FOR MAKING CUSHION COVERS

Cushion covers rank among the foremost of all the household articles for furnishing pupils with ample opportunity for exercising their decorative powers, both in the development of the design and the use of the many and varied embroidery stitches already memorised. These covers may be made in a variety of shapes, the square and oblong being the simplest of all. A convenient size for a square cushion is 22 in., and for an oblong cushion, 19 in. by 23 in. Cut two pieces of linen to the shape required allowing for turnings. Work a design in the centre, or as a border, on one piece before machining the two pieces together along three edges. Make a cord of embroidery cottons and attach it to the edges of the cushion over the join.

A novel way of forming an edge to a cushion is to work a narrow hem-stitched hem along the edges of one piece. Join the second piece to the first just to the inside of the hem-stitching, so that the hem forms a decorative border for the cushion. An attractive way of obtaining a square piece of material for a cushion is to join remnants of two different materials, or two different colours of the same material, in the manner shown in Fig. 1, the variation in shading indicating the various colours. These may first be machined together, the seams being covered afterwards with couched threads.

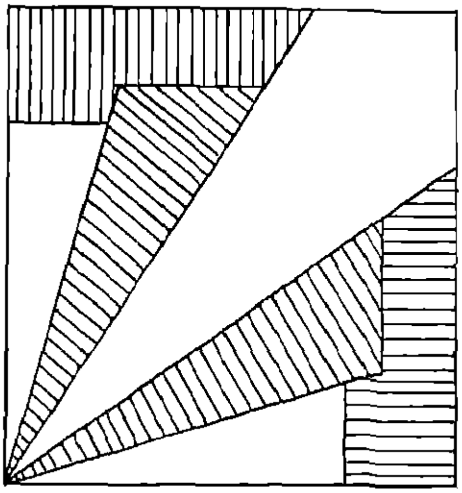


FIG. 1

Cushions may also be made oval-shaped, circular, or in the shape of a fan. These forms of cushion look very effective when carried out in taffeta silk or artificial silk, and may be ornamented with ruchings of the same silk, or have sections filled in with very finely pleated silk. Piping cords play a great part in the construction of cushions of the present day, serving the useful purpose of finishing off the edges of the cushion and at the same time forming a decoration. Coloured braid of various kinds provide excellent trimmings, as also gaily coloured tassels which look most effective hanging from one or more corners of the cushion.

III. REPAIR WORK—REPAIRING GLOVES

Aim of lesson.—To teach the pupils the art of repairing gloves neatly.

Arrangement of lesson.—The pupils repair their own gloves as the teacher demonstrates.

Teacher's requirements.—A large glove roughly made in hessian; coloured wools; needle; gloves already repaired in different ways; chart illustrating the processes; scissors; thimble.

Children's requirements.—Worn gloves; needle; cotton; scissors; thimble; notebook.

DEMONSTRATION

1. Woollen gloves are darned in the same way as stockings.

2. Cotton or silk gloves are closely darned with fine thread of the same colour as the gloves.

Skin gloves.—

1. When the stitching of a seam is broken, and the seam splits open, place the two edges of the seam together and stitch through the original holes.

2. When the skin itself is split, buttonhole-stitch the raw edges on each side of the seam separately, and sew or buttonhole the knots together, Fig. 1.

3. For a small hole, buttonhole the raw edges and fill in the hole with rows of buttonholing, the stitches of one row being worked into those of the previous row, Fig. 2.

4. A split caused by tightness, or a large hole, must be patched. Cut a piece of skin to fit the hole—from the wrist portion of an old pair of gloves if possible. For a split, this must take the form of a gusset-shaped piece. Buttonhole round the edge. Buttonhole the edge of the hole, place the patch in the hole, and sew the knots on the patch to the knots on the glove.

5. An alternative method of patching a large hole is to place the patch on the wrong side and closely sew down the edge of the hole on the right side, leaving the edges on the wrong side free.

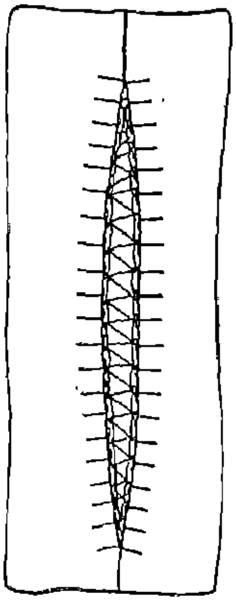


FIG. 1

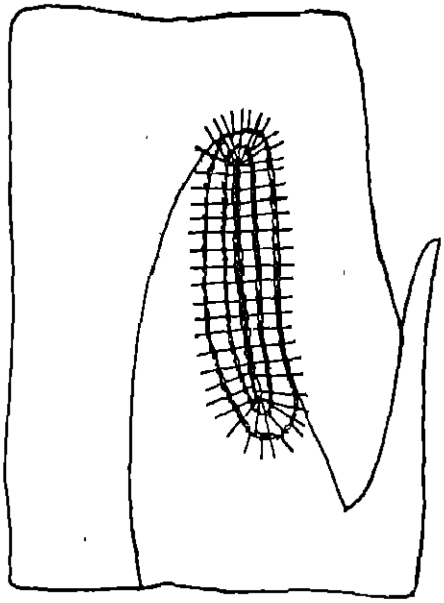


FIG. 2

THE MOTHERCRAFT COURSE OF NEEDLEWORK

THE making of an entire outfit for a baby provides a most suitable needlework scheme for older girls, especially for those who are taking the full mothercraft course. The fashioning of garments for the tiny helpless wearer calls forth those qualities which ensure the making of a very dainty and useful set of garments.

In the teaching of this course, the teacher must be provided with large apparatus to correspond with the article to be made, together with the necessary sewing requisites; blackboards and their accompanying equipment; charts illustrating the different processes involved in the construction of the various articles; completed specimens of the articles in question for reference purposes. In each article of the course, the requirements necessary for the making of that article are stated. Each child must be equipped with these requirements, sewing accessories and notebook at the beginning of each lesson.

The inclusion of a baby's cot, to be made and furnished by the girls themselves, greatly adds to the interest in the mothercraft scheme. This may be made quite easily from a banana crate, bought from a wholesale fruiterer, to which must be attached pieces of wood suitable for legs and the framework of a canopy, Fig. 1.

THE COT

Preparing the cot.—

1. Glasspaper the sides of the crate, inside and outside, until they are perfectly smooth.

2. Cut the pieces of wood for the legs and the canopy, and glasspaper them also, afterwards fixing them in position to the cot. Bore holes at each corner as in Fig. 1.

3. Give the whole of the cot two or three coats of white paint, allowing each coat to dry before applying the next, and finish off with a coat of white enamel.

4. When the cot is completely dry, stencil "bunnies" and "chicks," or any other decoration suitable for the nursery, on the sides of the cot, Fig. 1.

Furnishing the cot.—

1. Measure the inside of the cot and make a bed from strong ticking filled with flocks.

2. Make a pillow in the same way to fit at the head of the cot under the canopy.

3. Make a cover of strong twill for the bed and the pillow, and a dainty pillow case from muslin, organdie, or fine linen suitably embroidered in each corner, or along the top edge only. (Embroidery must never be worked where the baby's head will lie.)

4. Cut sheets and blankets to the required size, remembering to make a sufficient allowance along the long sides and bottom edges for tucking under the bed. Turn over the edges of the blankets once and blanket-stitch them with white or pastel-shaded wool.

5. Make a dainty coverlet for the bed of the same material as the pillow or of artificial silk in a pastel shade, and work suitable embroidery on it; e.g., "Baby" worked in padded satin stitch, or animals appliquéd to it. If preferred, slots may be worked across it through which broad satin ribbon is threaded and tied in a bow.

6. Cover the sides of the cot with a frill of spotted muslin or flowered organdie as follows:—

Measure all round the cot and cut a length of material equal to one and a half times or twice the measured length. (This allows for gathers.) The material must be cut deep enough to cover the sides of the cot when finished, and allowance must be made for a narrow hem along the bottom edge and a $1\frac{1}{2}$ in. hem along the top edge. Join

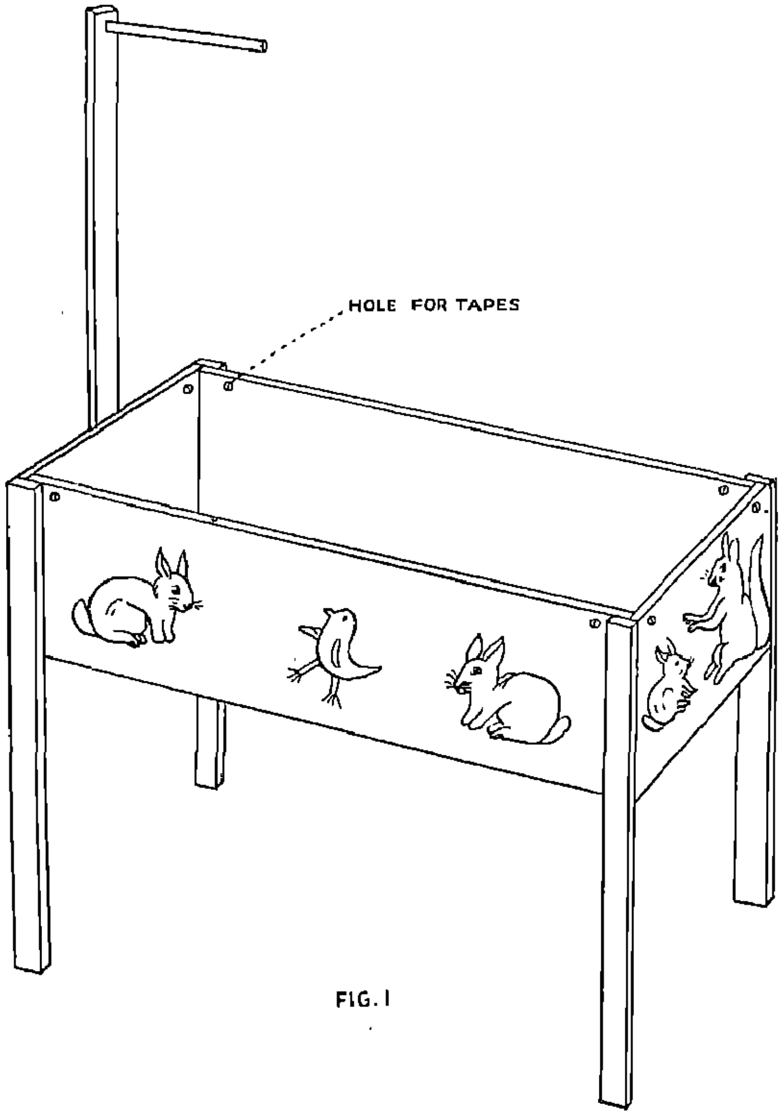


FIG. I

THE COT—MADE FROM A BANANA CRATE

the length of material to form a ring, and machine the hems along the top and bottom edges. Run another line of machining $\frac{1}{2}$ in. away from the first line along the top edge to form a slot. Work a buttonhole in this slot near the join on the wrong side of the hem through one thickness of material only. Cut a length of very narrow tape equal in length to the measurement of the four sides of the cot, and allow about 9 in. more for a bow to be tied. Insert this tape through the slot, draw up the material to the required size and tie the tape in a bow. Regulate the gathers of the frill, and at each corner stitch a piece of tape on to the slot of the frill. Pass these tapes through the holes at each corner of the cot (Fig. 1) and tie them in a bow, Fig. 2.

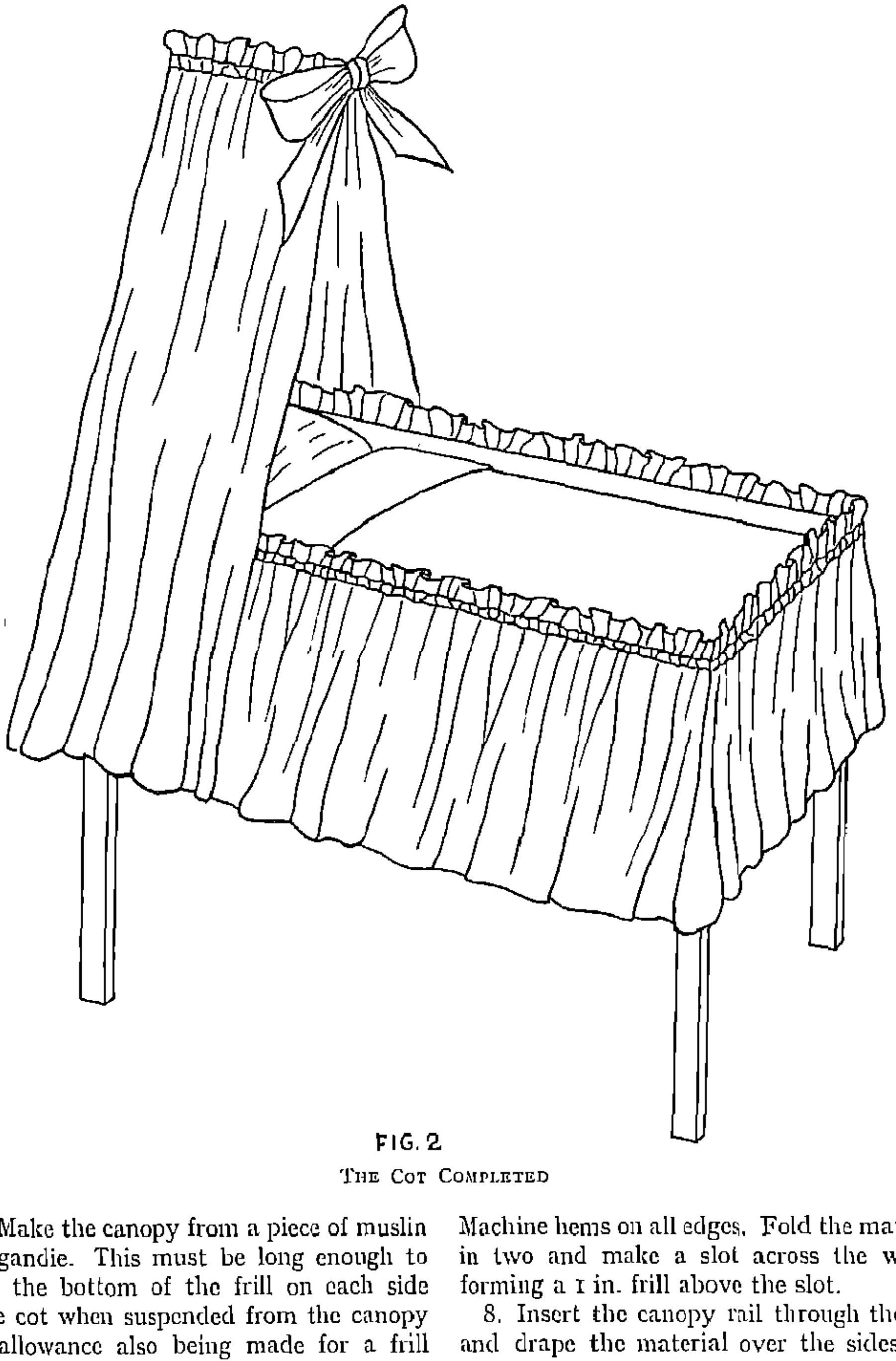


FIG. 2

THE COT COMPLETED

7. Make the canopy from a piece of muslin or organdie. This must be long enough to reach the bottom of the frill on each side of the cot when suspended from the canopy rail, allowance also being made for a frill above the slot, and wide enough for the two edges to meet at the centre back of the cot when the cover is draped in position. Machine hems on all edges. Fold the material in two and make a slot across the width, forming a 1 in. frill above the slot.

8. Insert the canopy rail through the slot and drape the material over the sides and the back of the cot, Fig. 2.

9. Decorate with a bow of broad satin ribbon, Fig. 2.

THE LAYETTE

Baby's first clothes known as the "layette," are the "long clothes." These should not be too long, as they were in former days, but just long enough to ensure warmth and comfort for the baby. The new approved length of about 24 in. is long enough for the beginning. As baby grows, the garments will naturally become shorter, and the layette may easily be turned into baby's second set of clothes, the "short-coating set," with the addition of a few tucks just above the hems, thus incurring no waste of a set of garments.

For the layette the articles to be made are:—binder or swathe; napkins; pilch; long flannel or barracoat; long petticoat; day robe; nightgown; coat, and bonnet. For knitted woollen garments to be included in the layette; e.g., vest, suitable instructions may be obtained from any of the modern knitting books.

BINDERS

These must be made of very soft baby flannel as narrow as possible and yet capable of fulfilling the purpose for which they are intended.

Requirements.—The binder must wrap one and a half times round the baby's abdomen, and be cut to a width of 4 in. to 4½ in., so that two binders may be made from ¼ yd. of flannel 28 in. wide; silk floss; tape.

Cutting out.—

1. Tear the flannel to the required width from selvedge to selvedge, and cut to the required length.
2. Curve the four corners.

Making up.—

1. Overcast the raw edges with silk floss.
2. Stitch a short tape at each corner of one end and a long tape at each corner of the opposite end.
3. Measure along the binder from the end to which are attached the long tapes, the length round the baby's body minus 1½ in. At this point, close to the top and bottom edges, make a slot. Pass the long tapes through these slots, adjust the binder, and tie at the side, Fig. 1.

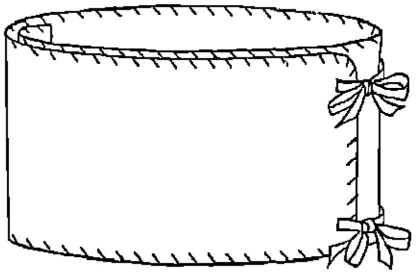


FIG. 1

NAPKINS

Requirements.—Napkins should be made of the softest Turkish towelling procurable. They vary in size from 18 in. square to 27 in. square, and the towelling may be bought by the yard in the width required.

Making up.—

1. Cut the towelling into squares.
2. Turn over the raw edges and herringbone them down.

PILCHES

A pilch is worn over a napkin and should fit the body loosely. It must be cosy and warm, a soft flannel being the most suitable material.

METHOD 1

Requirements.—A very simple form of pilch may be made by cutting ¾ yd. of 27 in. wide flannel diagonally, each half forming a pilch; soft material suitable for binding the edges.

Making up.—

1. Bind or face all the edges with the soft material.

2. Fold over the corners of the diagonal and fasten with a button and a buttonhole.

3. Make a loop or buttonhole on the remaining corner and fasten it on to the centre button, Fig. 2. Tapes may be used for the fastening if desired, in which case make a loop on the third corner.

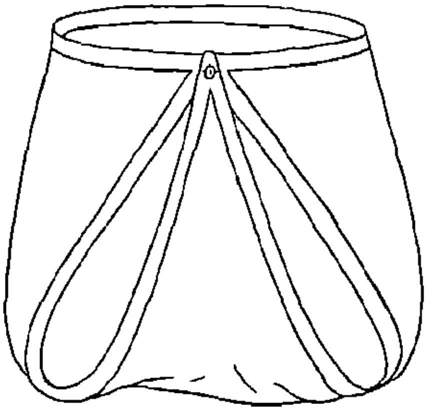


FIG. 2

METHOD 2

A more complicated form of pilch is drafted as in Fig. 3. AB = 16 in. BC = 20½ in. Complete the oblong. BE = ½ in. AF = 2 in. Join EF with a curved line. AG = 11 in. GH = 1½ in. GJ = 3¼ in. Join FH and HJ. KL = 4¼ in. CM = 2½ in. MN = 1¾ in.

Join CN. Join JN with a curved line passing through L, curving 1¾ in. from the centre of JL. Cut out on the pattern lines, Fig. 3.

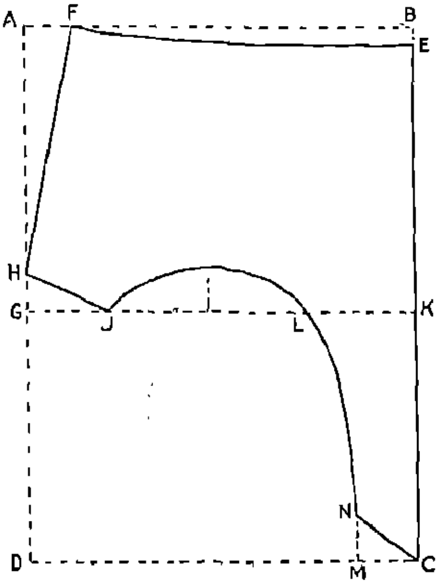


FIG. 3

Cutting out.—Place the pattern on 1 yd. of 22 in. wide flannel with the line EC to the fold. Cut out, allowing turnings if the edges are to be faced.

Making up.—

1. Bind or face all the edges.

2. Arrange the fronts to button. Make a buttonhole in the "tab," and fasten up the tab to one of the buttons, Fig. 4.

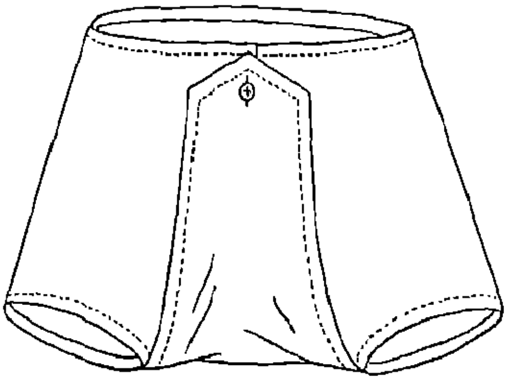


FIG 4

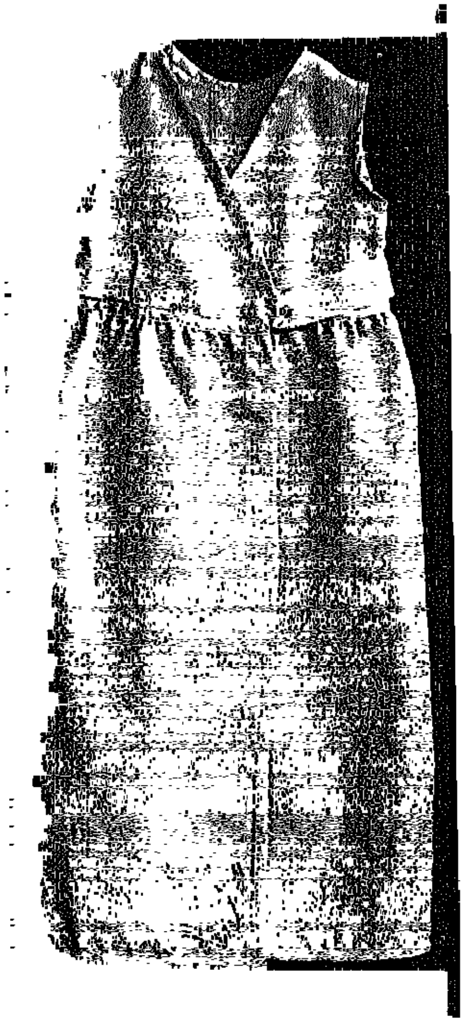
LONG FLANNEL OR BARRACOAT

Drafting the pattern.—

1. For the bodice, draft the pattern as in Fig. 5.

AB = 10 in.; BC = 7½ in.; AE = 1½ in. AF = 2¼ in. (Join EF with a curved line.) AG = 1 in. (for the shoulder line). BH =

2¼ in; FJ = HK = 2⅛ in. (to touch the shoulder line). JL = ⅓ JK. Draw in LM. MN = 3 in. Draw in the armhole curves, curving to ½ in. in the back portion and 1 in. in the front. CO = 3 in. Join HO. Curve the corner. Cut out on the pattern lines.



Long Flannel or Barracoat

2. For the skirt, cut an oblong with the length equal to 16½ in. and the width equal to 18 in.

Requirements.—Soft baby flannel (if the skirt is made in one piece it must be cut the wrong way of the material, 1¼ yd. of 28 in. wide material being required; if the skirt is cut the selvedge way of the material, then a join must be made); ½ yd. of artificial silk cut in crossway strips, or embroidery silk; ¾ yd. of ribbon.

Cutting out.—

1. Place the skirt portion with the length to the fold of the material, and cut out allowing turnings on all edges, unless the edges are to be bound, in which case turnings must be allowed along the top edge only.

2. Place the centre back of the bodice to the fold of the material and cut out, allowing turnings on all edges, or along the shoulders only.

3. Cut the back of the bodice again to the under-arms only.

Making up.—

1. Tack the separate back bodice portion inside the bodice and machine the two together with rows of machining as for quilting.

2. Join the shoulder seams with a flannel seam, made as follows:—

Place the two edges together and make a plain seam. Flatten the seam by laying the turnings to right and left and tacking them down to the garment, Fig. 6. Herring-bone each side over the raw edges to keep the seam flat, afterwards removing the tacking threads, Fig. 6.

3. Bind all the edges of the bodice, and the front and bottom edges of the skirt with sarcenet ribbon or crossway strips cut from the artificial silk. Scalloping may be preferred to binding. If scalloping is used, then only the bottom edge of the bodice must be bound, all other edges being scalloped, Fig. 8.

4. Gather the top edge of the skirt and set it under the bodice.

5. Neaten all raw edges with overcasting or binding.

6. Make a slot at the right side of the bodice.

7. Stitch ribbon strings on each end of the bodice, pass one through the slot and tie at the back, Figs. 7 and 8.

8. Embroider a design in the bottom corner.

LONG PETTICOAT

The long petticoat may be made in one of two styles, namely, all in one piece and gathered at the neck, or composed of a bodice and skirt.

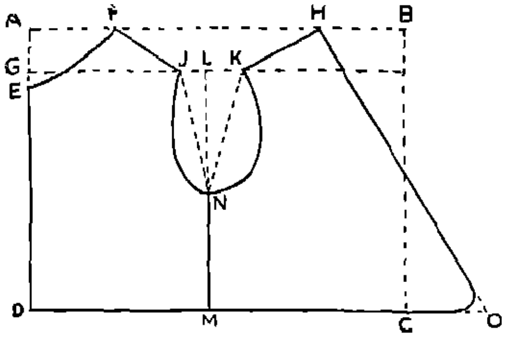


FIG. 5

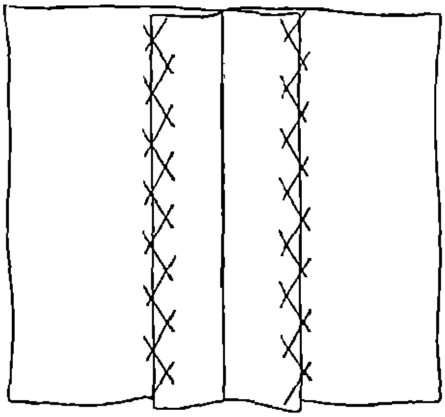


FIG. 6

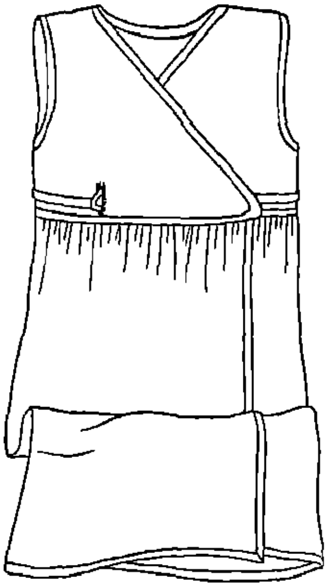


FIG. 7

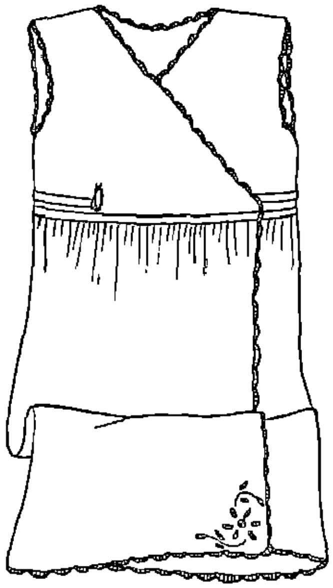


FIG 8

Drafting the pattern.—

Draft the bodice pattern as in Fig. 9. AB = 12 in.; BC = 7¾ in. Complete the oblong. AE = 1¼ in. AF = 1¾ in. for the back neck curve. BG = BH = 1¾ in. for the front neck curve. AJ = ½ in. for the shoulder line. FK = HL = 2½ in. (drawn to the shoulder line). KM = ⅓ KL. Draw in MN. NO = 2¾ in. Draw in the armhole curves as in the diagram. Cut out on the pattern lines.

Style 1

Using the bodice draft, make the following alterations:—

Back.—

1. Allow for gathers by widening at the neck.
2. Lengthen so that the full length from the shoulder to the hem equals 24 in.
3. Widen the bottom to 9¼ in. and slightly curve to avoid a dip, Fig. 10A.

Front.—

1. Alter as in Fig. 10B for gathers at the neck.
2. Widen the bottom 10 in. and curve as in Fig. 10B.

Requirements.—¾ yd. of 48 in. wide nainsook; 5½ yd. of lace; 1¼ yd. of ribbon.

Cutting out.—

1. For the back pattern measure 9½ in. from one selvedge and fold the material. Fold over the other selvedge to meet the first for the front pattern.
2. Place the centre front and back patterns each to a fold, and cut out, allowing ¼ in. turnings on all edges. Thread-mark the bottom edge of the bodice pattern.

Making up.—

1. Along the thread-marked line make slots in three groups of two on the front and back pieces.
2. Join the shoulder and under-arm edges with tiny run and fell seams.
3. Turn a narrow hem along the bottom edge and trim with two rows of lace, one along the edge and the second row 1 in. away from the first.
4. Make the centre back placket.
5. Turn hems along the neck and armholes and trim with lace.
6. Thread a draw-string through the neck hem and thread ribbon through the slots, Fig. 11.

Style 2

Use the bodice draft for the bodice, but for the skirt, cut an oblong 16¼ in. long and 19½ in. wide.

Requirements.—As for Style 1, with the addition of ¾ yd. of lace insertion.

Cutting out.—

1. Place the centre front of the bodice to the fold of the material, allow a little extra for tucks, and cut out, allowing ¼ in. turnings on all edges except the bottom, where ⅛ in. turnings only are allowed.
2. Cut out two back pieces, allowing turnings as for the front.
3. Place one of the 16¼ in. long sides to the fold of the material, and cut out, allowing ¼ in. turnings on all edges except the top, where ⅛ in. is allowed.

Making up.—

1. Pin-tuck the bodice front.
2. Join the shoulder and under-arm edges with a tiny run and fell seam.
3. Make the centre back placket.
4. Hem and trim with lace the neck and armholes.
5. Join the sides of the skirt with a run and fell seam.
6. Hem and trim with two rows of lace the bottom edge.
7. Join the insertion to the bottom edge of the bodice by means of whipping.
8. Gather the top edge of the skirt and whip it to the bottom edge of the insertion.
9. Fasten the neck with loops and buttons or ties, Fig. 12.

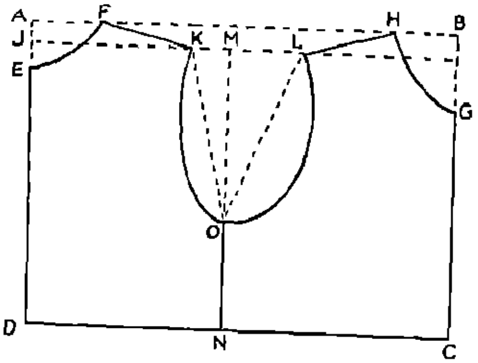


FIG. 9

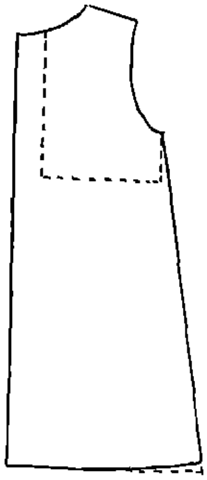


FIG. 10A

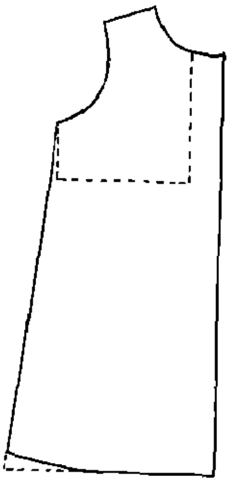


FIG. 10B

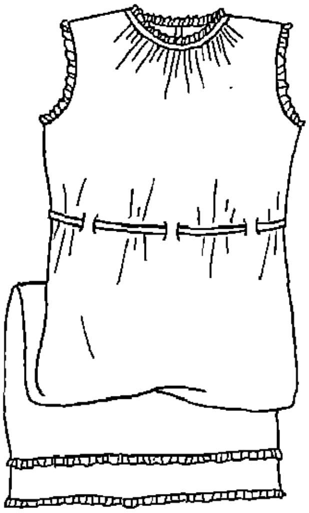


FIG. 11

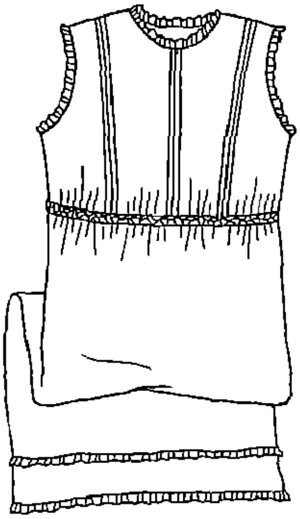


FIG 12

DAY ROBES

Day robes may be made with or without a bodice, as in the petticoat.

Drafting the pattern.—

1. Using the bodice draft already drafted for the petticoat, lower the armhole ¼ in. in both the back and front portions.
2. Draft the sleeve pattern as in Fig. 13.

AB = 10¼ in. BC = 7 in. Complete the oblong. AE = ½ AB.

AF = BG = 2½ in. Curve the line CD downwards to ¼ in. in the centre.

Requirements.—The full length of the day robe is required, from shoulder to hem, plus the length of a sleeve of 39 in. wide material, such as lawn; and enough lace to trim as desired.

Cutting out.—Cut out as for the petticoats, allowing extra material where tucks are required. Cut the sleeves longer or shorter as desired.

Making up.—Make tiny French seams at the shoulders, sleeves, and sides of the robe. Set in the sleeves with fine gathers at the top, then proceed as for the petticoat, trimming according to taste.

Fig. 14 shows a robe having pin-tucks along the front, short sleeves gathered and set in a band, and trimmed with lace.

Fig. 15 shows a robe pin-tucked at the shoulders, back and front, and trimmed with insertion to the bottom of the bodice, where slots are made through which ribbon is threaded. The sleeves are fairly long, scalloped and slotted, and the bottom edge is scalloped.

Fig. 16 shows a robe with a bodice which is pin-tucked, trimmed with insertion and set on a gathered skirt. The sleeves are long and gathered with ribbon.

NIGHTGOWNS

These are made from the same pattern as the day robes. A shorter yoke may be cut if desired, the skirt being cut longer accordingly. When cutting out, allowance must be made for a hem ¾ in. wide along the bottom edge; the sleeve must be cut long and narrowed ½ in. at each side, so that there are not too many gathers on the

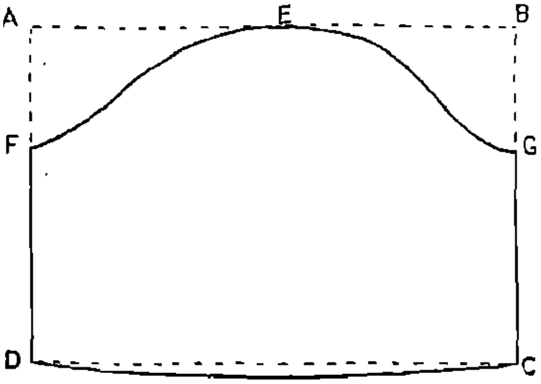


FIG. 13

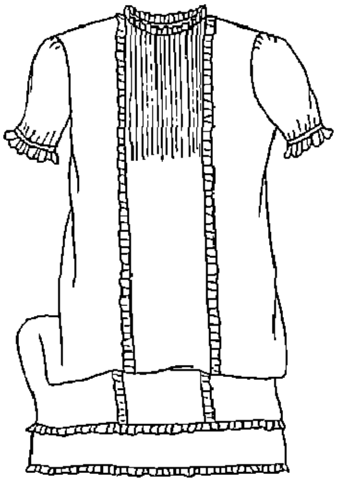


FIG. 14

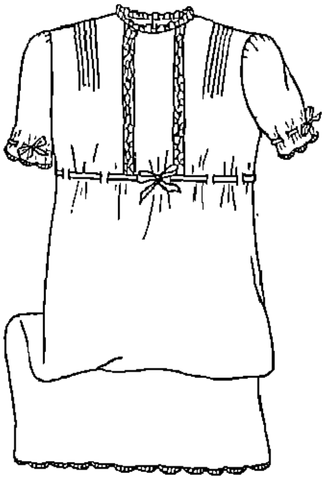


FIG. 15

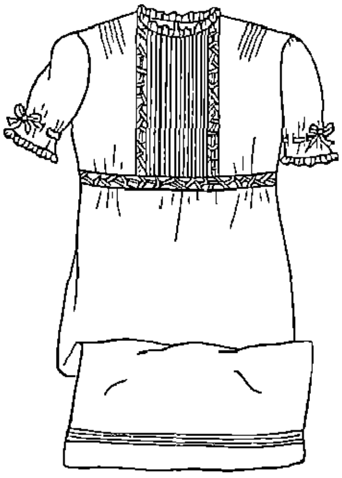


FIG. 16

shoulder, as the material for a nightgown is of a much thicker texture than a day robe.

Requirements.—As for a day robe—winceyette is a suitable material.

Fig. 17 shows a nightgown with a yoke tucked and trimmed with insertion. The yoke and gathered skirt are set into a band over which loops are made to form slots.

In Fig. 18, the front yoke is box-pleated in the centre, the pleat being trimmed with lace at each side. The front and back yokes are gathered into a shoulder yoke, and the bottom edges of the yoke and the gathered skirt are set into a band which may be embroidered with decorative stitchery if desired.

Fig. 19 shows a nightdress cut without a yoke and gathered at the neck. The gathers are set into a short band at the centre front, the remaining portion of this band forming strings to be tied at the back.

BABY'S LONG CLOAK

Drafting the pattern.—

1. Using the bodice draft, measure 4 in. from the shoulder down the back and front, and cut out a yoke.

2. From the remainder of the bodice pattern cut out the skirt portion, allowing about 3 in. extra in the width in both the back and front portions, making it 23 in. in length.

3. Cut out a cape pattern in the same manner as for a collar, making it 11 in. deep, and *curving the bottom corners at the front.*

4. Cut out a sleeve pattern as for a nightgown, narrowing it to 8 in. at the wrist.

Requirements.—Twice the length of the skirt plus the width of the cape from the bottom of the front over the shoulder to the bottom of the back; i.e., about 2 yd. of 38 in. material such as woolalone or nun's veiling; silk braid—enough to bind all the outside edges of the coat, cape and sleeves.

Cutting out.—

1. Place the cape pattern on the material with the centre back to the fold, and cut out, allowing ⅜ in. turnings round the neck edge only.

2. Fold the material wide enough to take the skirt part, place the patterns with the centre back and front to the fold, and cut out, allowing ⅜ in. on all edges except the bottom. Cut up the centre front fold to separate the pieces.

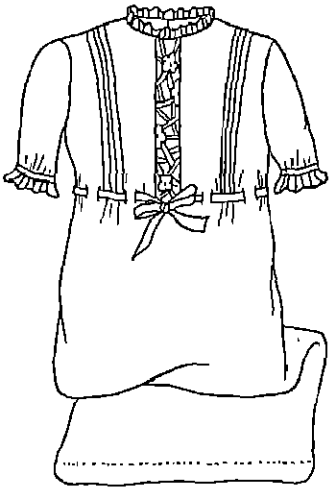


FIG. 17

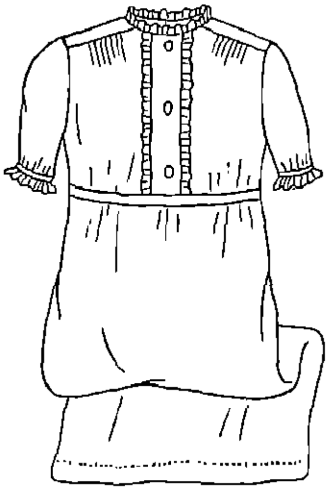


FIG. 18

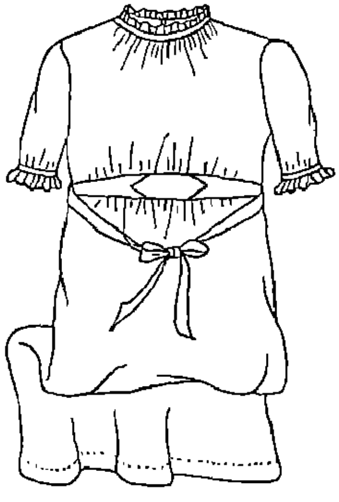


FIG. 19

3. From the remainder of the material cut out (*a*) two sleeves, allowing ⅜ in. turnings on all edges except the bottom, and (*b*) the back and front yokes, placing the centre back and front of the yokes to a fold, and allowing ⅜ in. turnings on all edges except down the centre front.

Making up.—

1. Turn under the bottom edges of the yokes, gather the top edges of the skirt portions, and set under the turned edges of the yoke. Decorative stitchery may be worked over the machining if desired.
2. Join the shoulders and under-arm seams.
3. Join the sleeves and set them in the coat.
4. Bind all the raw edges inside.
5. Using the silk braid, bind the fronts and bottom of the coat and the bottom of the sleeves.
6. Bind all round the cape, except the neck edge, with the silk braid.
7. Set in the cape as for a flat collar.
8. Fasten with ribbon ties, one at the neck and two down the fronts, Fig. 20.
9. Work a design in decorative stitchery in the corners of the cape.

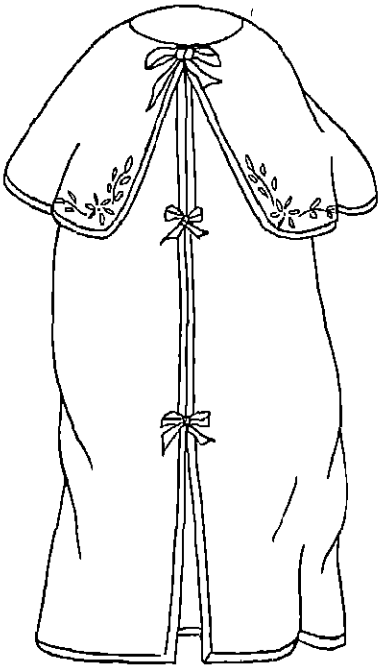


FIG. 20

After cutting out the cloak, a bonnet may be cut from the remainder of the material. For the drafts of different styles of bonnets refer to the *Children's Millinery*, pages 350–363.

SHORT-COATING SET

The garments to be made for the short-coating set are as follows:—pilch; flannel petticoat; petticoat; frocks; bib; coatee or matinée coat; coat and bonnet.

One set of garments may be obtained from the layette by cutting them shorter or shortening them by means of tucks, as the garments of the layette are made big enough, not only to allow the infant perfect freedom of movement, but also to provide for growth. When making a new set of clothes, use the bodice draft from the layette. When making garments with a yoke, make the yoke shorter than the one used in the layette—about 4 in. deep. Allow more fullness in the skirts; e.g., 48 in., if desired.

PILCH

Drafting the pattern.—Draft the pattern as shown in Fig. 1. AB = 6½ in. BC = 10 in. Complete the oblong. CE = 2¼ in. DF = 2½ in. Join EF with a curved line. BG = 5 in. Join GF. GH = ¼ in. BJ = ¾ in. Join HB and HJ with curved lines. Cut out on the pattern lines.

Requirements.—⅔ yd. of 28 in. wide soft baby flannel; 1½ yd. of ribbon; 1 knot of tape.

Cutting out.—

1. Fold the flannel to take the pattern.
2. Place BC to the fold, and cut out on

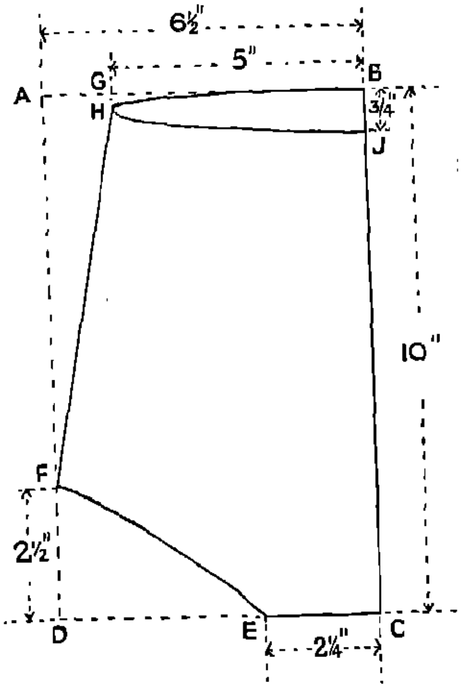


FIG. 1

all edges except EC, allowing ¼ in. turnings if necessary.

3. Turn over the pattern, keeping EC in the same position and cut out the front part of the pilch in the same way, thread-marking through HJ.

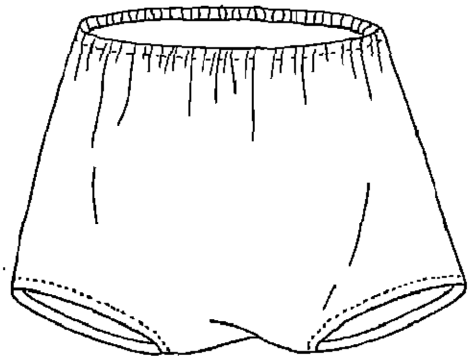


FIG. 2

Making up.—

1. Join the side seams with a flannel seam.
2. Bind or face the openings for the legs.
3. Face along the waistline to form a slot through which the tape is inserted and drawn up as required, Fig. 2.

Fig. 3 shows a flannel petticoat scalloped at the edges.

Figs. 4 and 5 show a petticoat and frock with the skirts tucked into a short yoke and trimmed with lace.

Matinée coats may be made to look very sweet and dainty with decorative stitchery or trimmings of lace as in Figs. 6 and 7.

Fig. 8 shows a coat with the fronts gathered into a shoulder yoke, and a narrow collar to take the place of a cape.

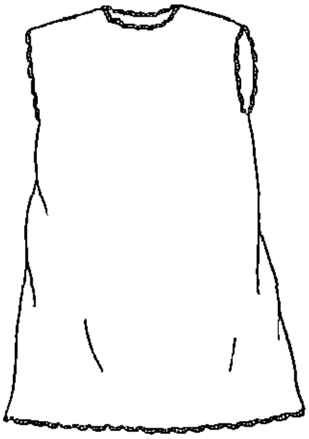


FIG. 3

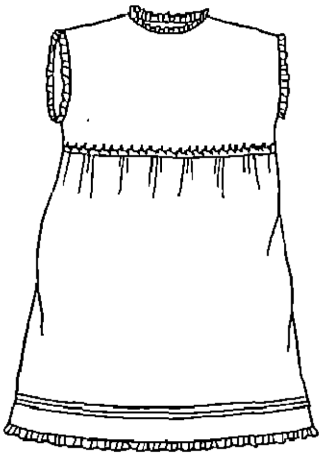


FIG 4

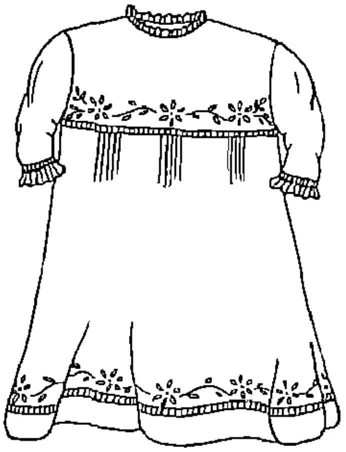


FIG 5

MATINEE COAT

BIBS

These may be made in a variety of shapes. Use the bodice draft to obtain the shape of the neck line, and draw to the desired shape in the same way as for a collar, narrowing at the centre back and widening at the centre front. Cut the bib out in muslin or the same material as the frock.

Decorate with stitchery and line with Turkey towelling. Fasten with ribbon ties or a loop and button.

Figs. 9, 10, 11, 12 and 13 show different shapes of bibs.

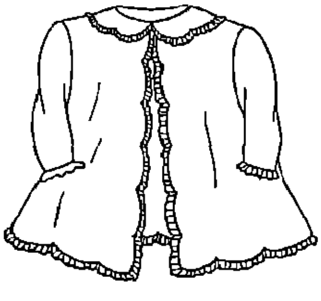


FIG. 6

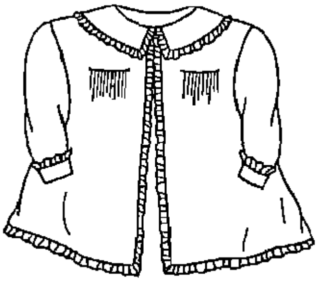


FIG 7

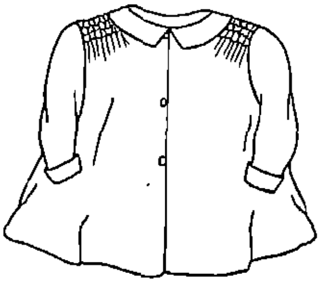
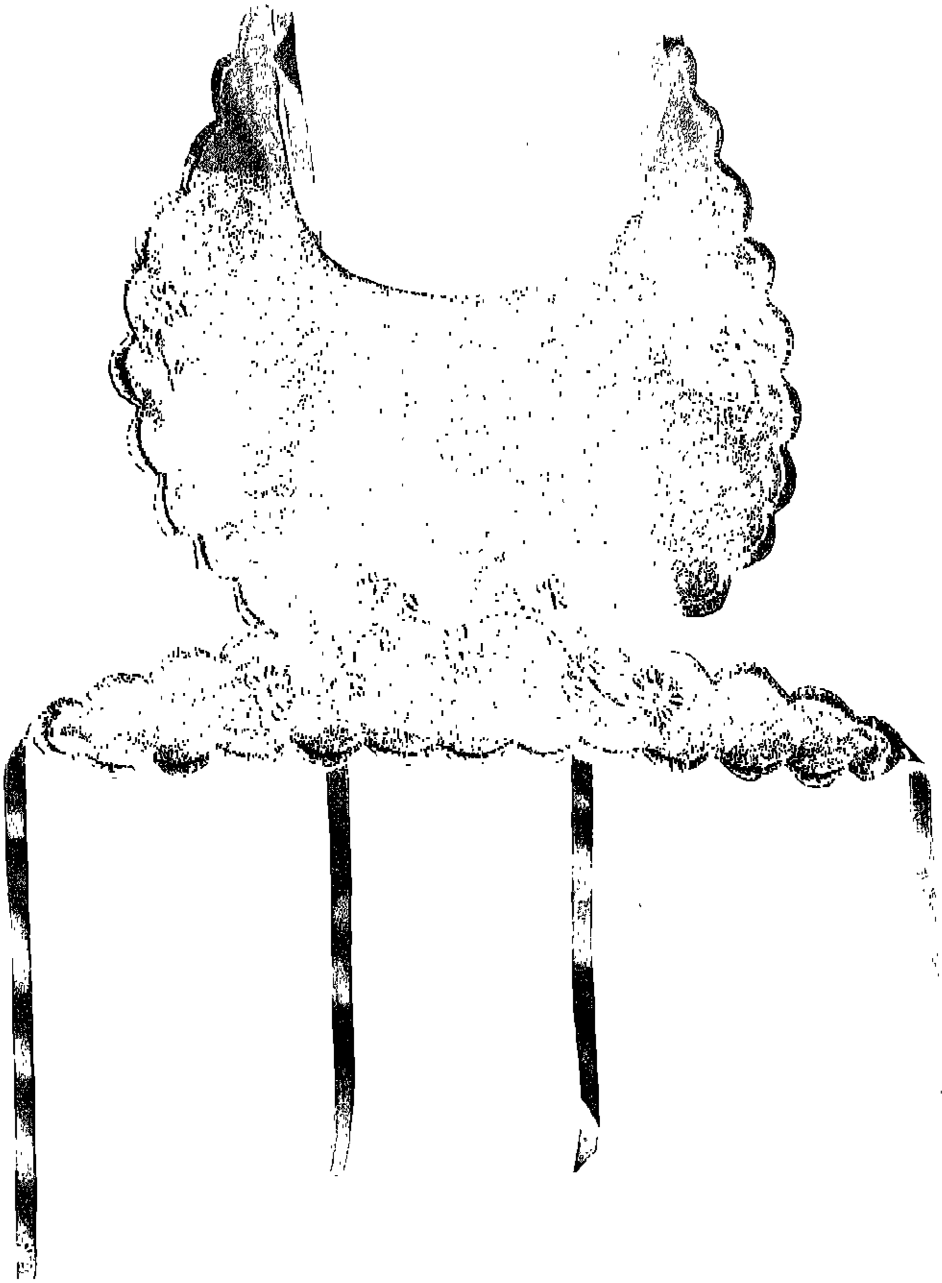


FIG. 8



Bib

PETTICOAT

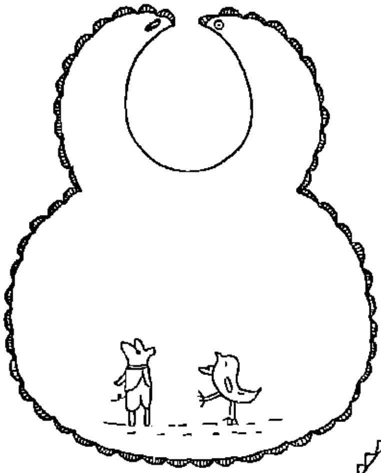


FIG. 9

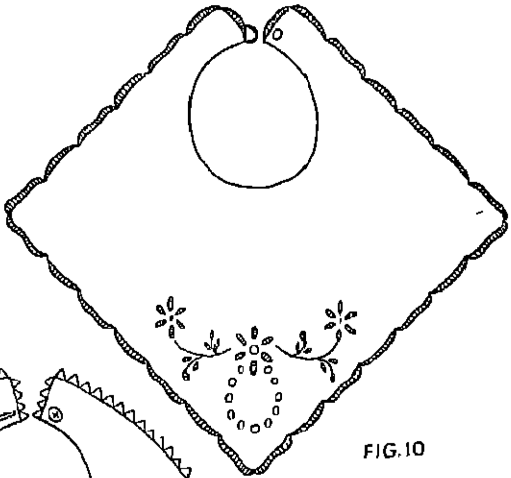


FIG. 10

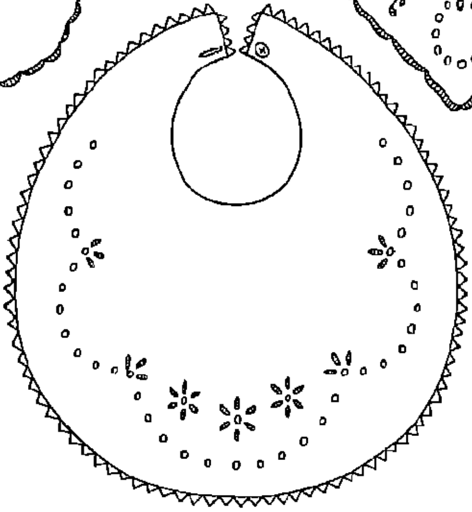


FIG. 11

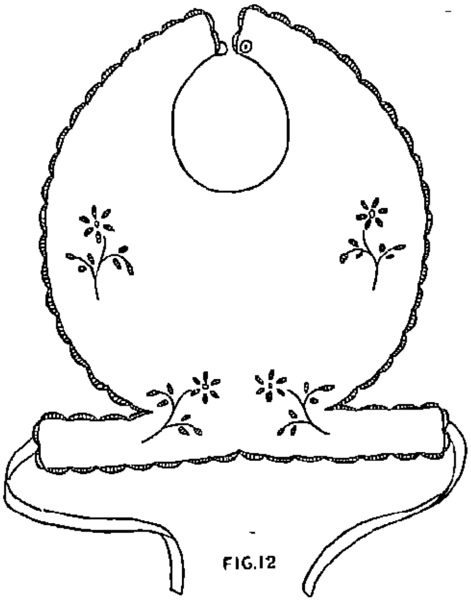


FIG. 12

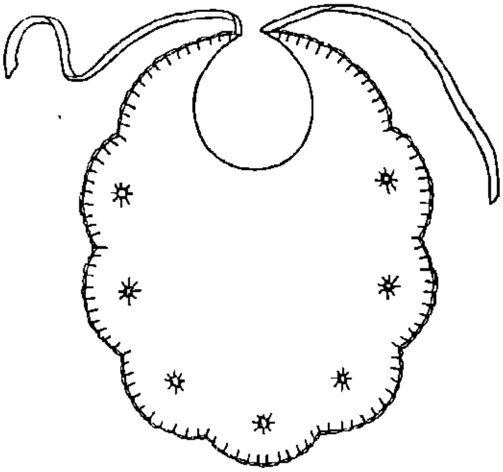


FIG. 13

Bibs

CHILDREN'S MILLINERY

CHILDREN'S millinery is an important branch of the mothercraft course. Babies naturally lie for the first few months of their lives, and it is essential that the head-covering be comfortable. Lightness in weight must be the outstanding feature when choosing the quality of the material. Consideration must also be given to the texture of the material so that it is suitable for the season of the year. Particular care must be taken to avoid friction from knots or seams. For infants' wear, white or pastel colours should be chosen. Hand embroidery, or finishings of frills, lace, swansdown and soft ribbon rosettes enhance the beauty of the head-covering, and make it more becoming to the small face. Simplicity of style must be borne in mind for ease in laundering.

ROSETTE MAKING—BABY RIBBON ROSETTE

This is to be used as a trimming when the strings are attached to the bonnet.

Requirements.—2 yd. of pale blue or pink satin baby ribbon (strips of pale coloured tissue paper may be used for the lesson instead of ribbon).

Making up.—

1. Wrap all the ribbon lightly round a flat school ruler, 1 to 1½ in. wide, starting at the top right-hand corner with the end of the ribbon on the under side of the ruler. The ribbon must end on the top left-hand side of the ruler. *N.B.*—Care must be taken that the loops are close together but do not overlap, Fig. 1.
2. Along the bottom of the loops run a gathering thread, beginning at the first loop on the right-hand side, Fig. 1.
3. Slide the ribbon off the left-hand side of the ruler; draw up the gathering thread tightly and end off the cotton well, Fig. 2.
4. The ends of the ribbon are fish-tailed; i.e., the ribbon is folded down the centre and a triangle is cut off from ½ in. down the centre to the outside corners of the ribbon, Fig. 2.
5. Arrange the loops artistically, and when attaching to the bonnet stab-stitch the gathered centres of the loops through to the side of the bonnet, Fig. 3.

A LOOPED ROSETTE

This is suitable for a baby girl's bonnet or a baby boy's hat.

Requirements.—1 yd. of 2 in. wide satin ribbon, either pale pink or pale blue.

Making up.—

1. Mark off 2 in. from the right-hand end for the first portion, then mark the remainder of the ribbon into 4 in. sections, leaving a 2 in. portion at the left-hand side of the ribbon. The marking must be done by means of lillikin pins to prevent the holes showing, Fig. 4.
2. Along each of these divisions run a gathering thread, Fig. 4.
3. Draw up each gathering thread tightly, and end off the cottons well, Fig. 5.
4. Fish-tail the ends of the ribbon, Fig. 5.
5. Loop the ribbon by catching the first gathered part to the second gathered part on the under side of the ribbon, then add the third, fourth and so on until all the ribbon is used, Figs. 6 and 7.
6. Arrange the loops artistically, and when attaching to the bonnet, stab-stitch through the gathered portions to the side of the bonnet, Fig. 8.

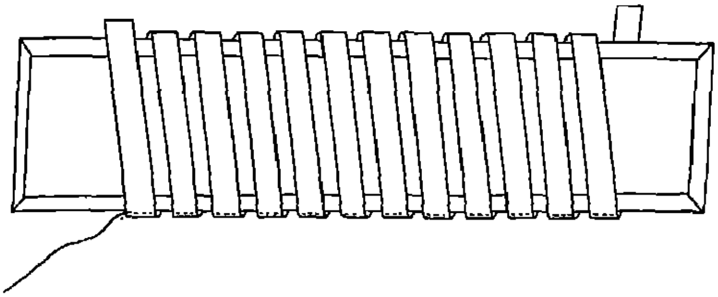
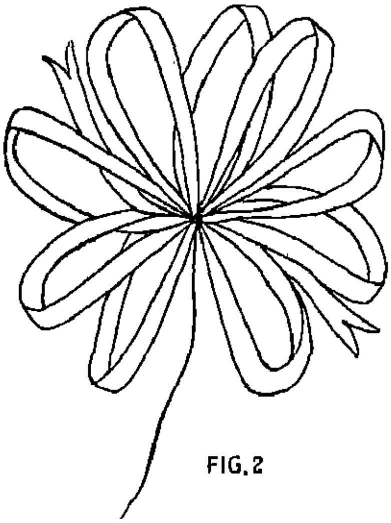


FIG. 1



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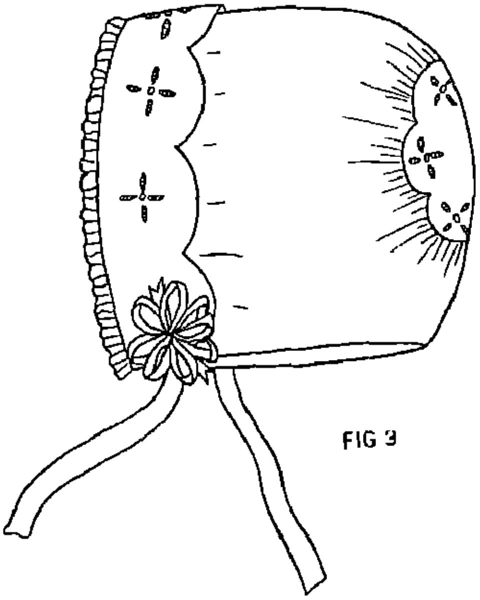


FIG 3

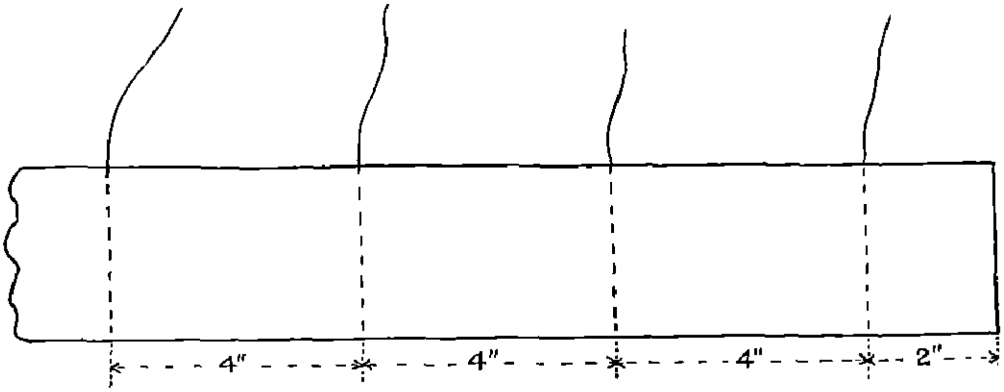


FIG. 4
Rosette Making

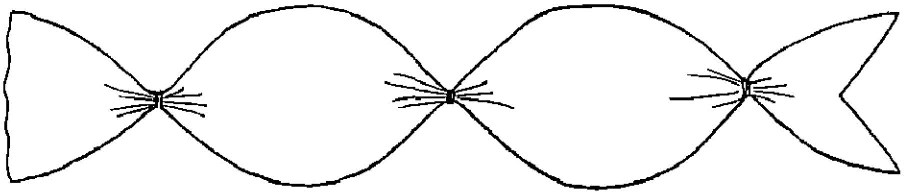


FIG. 5

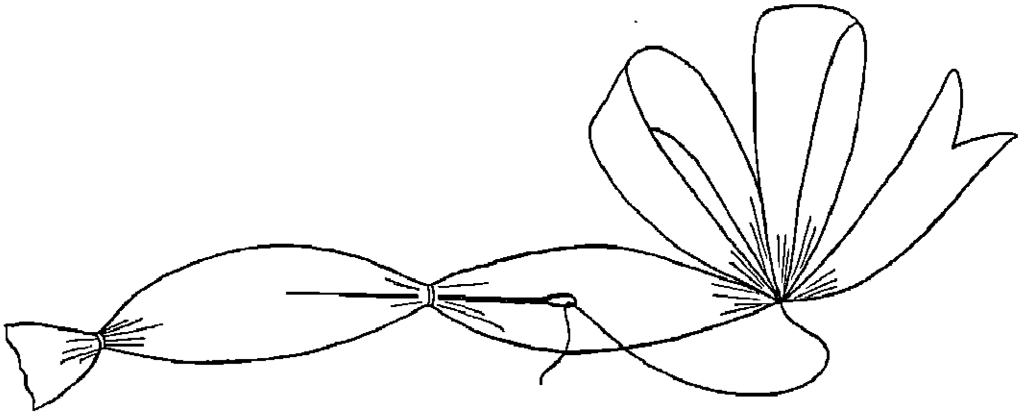


FIG. 6

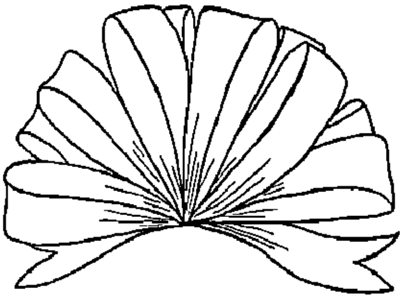


FIG. 7

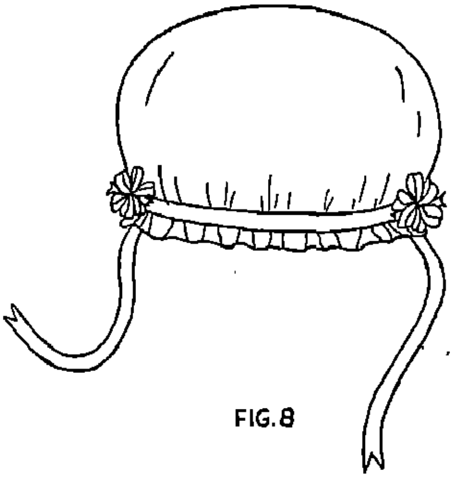


FIG. 8

Rosette Making

A BABY GIRL'S WASHING BONNET

Chief points in children's millinery.—

Bonnets must be:—

1. Light in weight.
2. Soft in shape.
3. Easy to wash.

Materials suitable for children's millinery.—Jap silk; crêpe-de-chine; spotted muslin; washing satin; lawn; tarantulle; organdie.

Measurements.—

1. Over the head from ear to ear (in this lesson—14 in.).
2. From the forehead to the nape of the neck (in this lesson—10 in.).
3. Round the back of the neck (in this lesson—7 in.).

Drafting the pattern.—

1. Make a circle 12 in. in diameter. Cut away a section 2 in. wide from the circumference to form the base of the bonnet, Fig. 1.

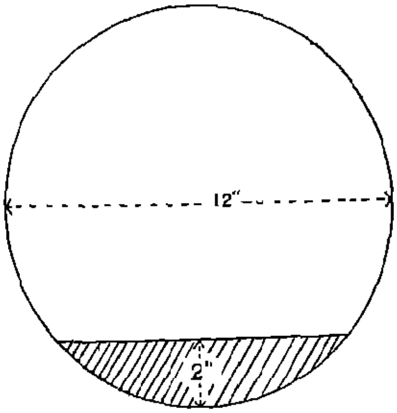


FIG. 1

2. For the coronet an oblong 14 in. by 4 in. is used. This may be designed to suit the required taste, either curved or scalloped, Figs. 2, 3 and 4.

Requirements.—⅓ yd. of washing material, 30 in. wide; ½ yd. of silk baby ribbon; 3¼ yd. of 2 in. wide satin ribbon; 1 knot of embroidery silk.

Cutting out.—Place the pattern on the material and allow turnings where marked in Fig. 5. Cut out.

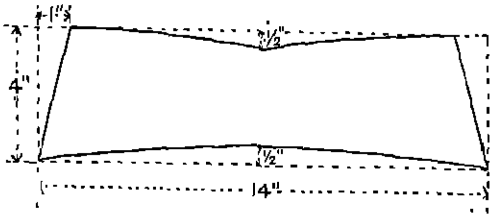
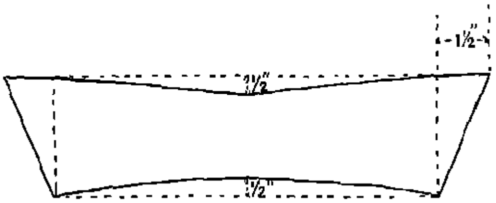


FIG. 2



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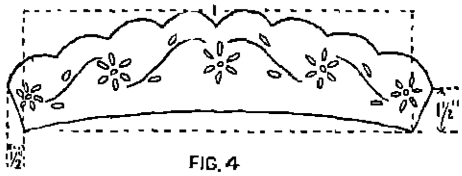


FIG. 4

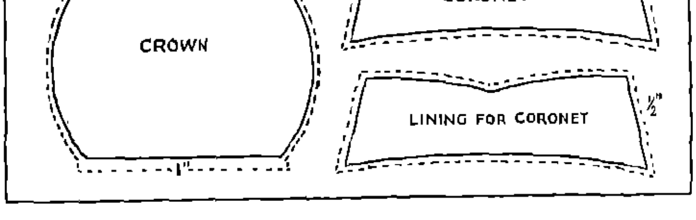


FIG. 5

Making up.—

1. Turn a ½ in. hem on the straight side of the crown piece, on the wrong side of the material.

2. Make a small buttonhole in the centre of the hem through the fold of the material, so that it does not come through to the right side of the material, Fig. 6.

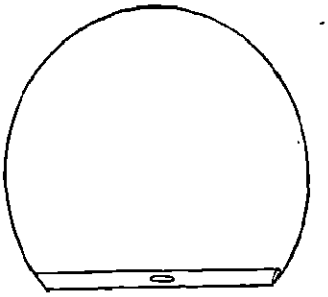


FIG. 6

3. Insert the baby ribbon through the hem, catch each end of the ribbon at each end of the hem, draw the remainder of the ribbon through the buttonhole, and cut into two equal lengths, Fig. 7.

This ribbon is drawn up and tied in a neat bow, and so can be untied for washing.

4. Put a gathering thread round the remainder of the crown piece ½ in. from the edge, Fig. 7.

5. Mark this gathered portion with lillikin pins into four equal parts.

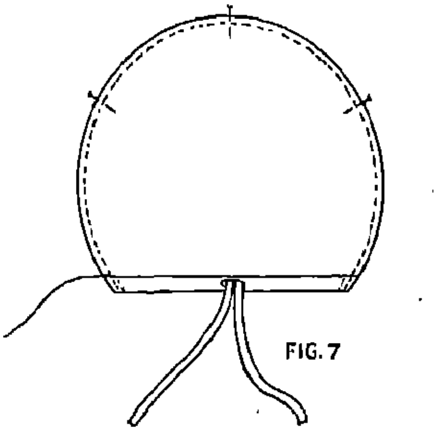


FIG. 7

6. Place the two sections of the coronet together, right side to right side, and join all the sides, except the side nearest to the face, with a small running stitch, Fig. 8.

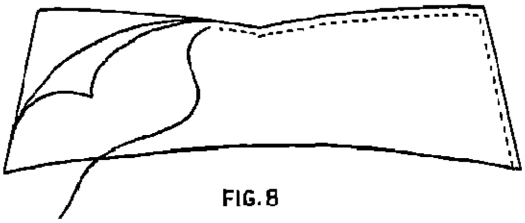


FIG. 8

7. Divide one edge of the open side of the coronet into four equal parts and mark with pins.

8. Draw up the gathering thread of the crown to fit the coronet, placing pin to pin. Join the two edges with a back stitch, having the material placed right side to right side.

9. Flatten the turnings of this join back to the inside of the coronet, and hem the remaining open side of the coronet down on to the turnings.

Trimming the bonnet.—

1. Draw faintly in pencil any simple design on the coronet of the bonnet.

2. Work over this in embroidery silk and

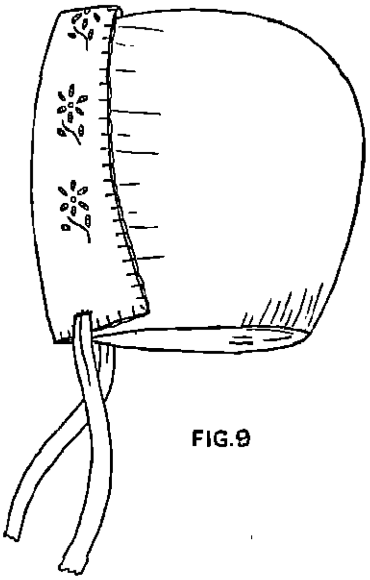


FIG. 9

buttonhole the outer edge of the coronet with the same kind of silk, Fig. 9.

3. Cut off two lengths of the satin ribbon, each 22½ in. long. Fold over one end of each piece and hem it down to the sides of the bonnet, Fig. 9.

4. Fix one of the two rosettes already described at each side of the bonnet, stab-stitching them down in position over these hems.

This completes the bonnet, Fig. 10.

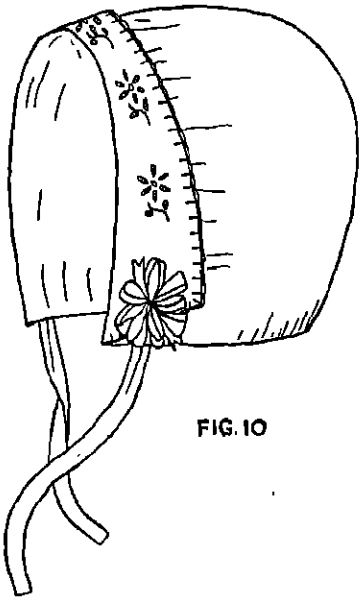


FIG. 10

A BABY BOY'S FIRST WASHING BONNET

Drafting the pattern.—

1. Make a circle 12 in. in diameter for the crown piece.

2. Make a second circle 12 in. in diameter and from it cut away a circle 11 in. in diameter. This leaves a circular piece ½ in. wide for a facing, Fig. 1. (The circles must be made smaller according to the baby's head size.)

Requirements.—⅜ yd. washing material 27 in. wide; 3¼ yd. of 2 in. wide satin ribbon; ½ yd. of swansdown; 1 knot of embroidery silk; ¾ yd. of silk baby ribbon; 1¼ yd. of ½ in. wide Valenciennes lace.

Cutting out.—Place the pattern on the material and allow turnings where shown in Fig. 2. Cut out.

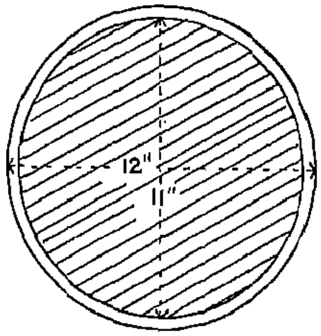


FIG. 1

Making up.—

1. Cut off 39 in. of lace and join the two cut edges, thus forming a ring of lace 38 in. in circumference.

2. With the scalloped edge of the lace facing the inside of the crown piece, place the straight edge of the lace to the circumference of the circle and tack in position, Fig. 3. The lace is fixed on the right side of the material.

3. Over the lace place the ½ in. facing with the outer edge touching the edge of the crown piece, having the right side of the material to the right side. Tack this facing in position and back-stitch the three edges together, Fig. 4. Remove the tacking threads.

4. Turn over the facing on to the wrong side of the crown piece, and tack round the outer edge to keep the facing flat, taking care to leave the lace standing outwards.

5. Turn in the ¼ in. turnings of the facing to form a hem and sew down, Fig. 5.

6. Put a running thread ¼ in. away from the hemmed edge all round the faced portion, thus forming a slot, Fig. 5.

7. In this slot make two small buttonholes through the facing only and ½ in. apart, Fig. 5.

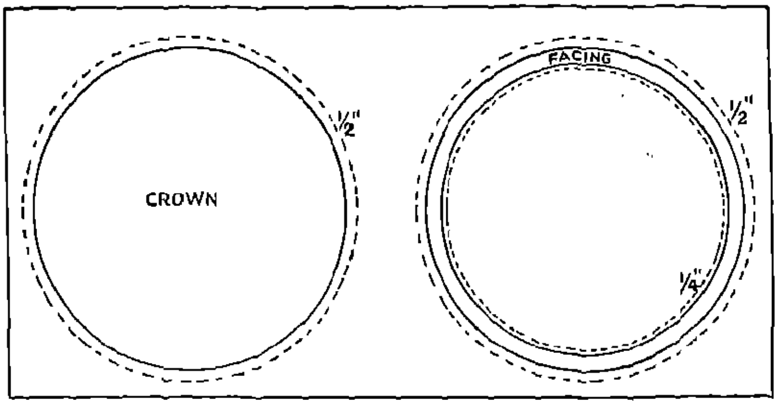


FIG. 2

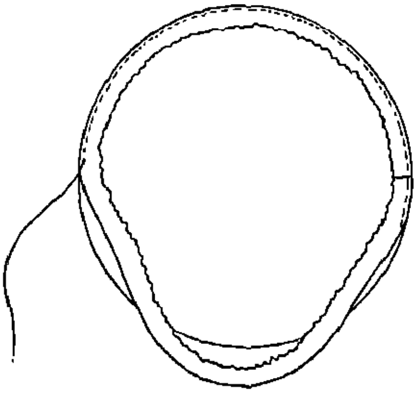


FIG. 3

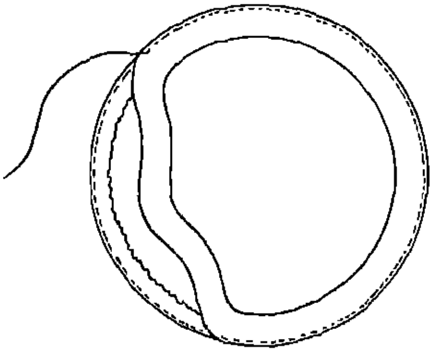


FIG. 4

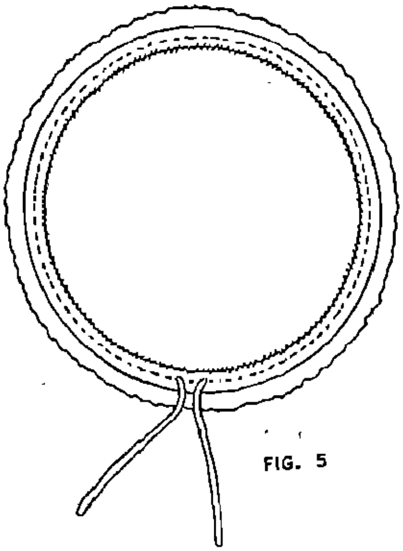


FIG. 5

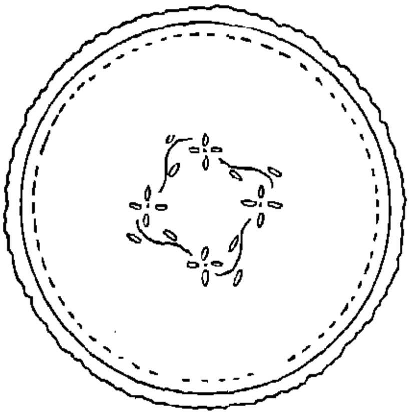


FIG. 6

A Baby Boy's First Washing Bonnet

8. Thread the baby ribbon through the slot so that it can be drawn up to fit the head size of the baby and be tied in a bow.

Trimming the bonnet.—

1. In the centre of the crown piece draw faintly in pencil a circular design about 3 in. in diameter, Fig. 6.

2. Work this with the embroidery silk in daisy stitch or satin stitch and stem stitch.

3. Draw up the bonnet to the required head size and tie the bow, Fig. 7. This bow is the back centre of the bonnet.

4. Attach the swansdown lightly on the right side of the material over the gathered slot, beginning at either the left or right side of the bonnet.

5. Cut two strings 22½ in. long from the satin ribbon and stitch neatly on the under side of the slot at each side of the bonnet. Mitre the loose ends.

6. Make a looped rosette for each side of the bonnet from the remainder of the ribbon.

7. Attach these in the swansdown over the place where the strings have been attached. This completes the bonnet, Fig. 7.

8. When washing the bonnet the swansdown and rosettes must first be removed.

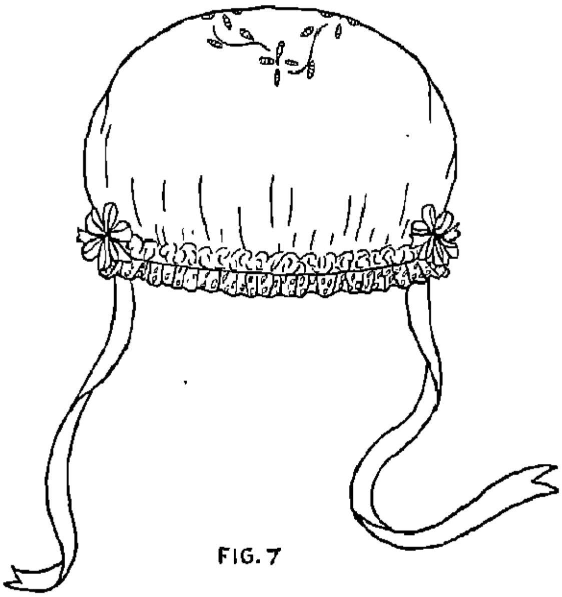


FIG. 7

A BABY GIRL'S BEST BONNET

Drafting the pattern.—

1. *The crown part.*—Make an oblong 16 in. by 6 in., ABCD, Fig. 1. Along AB measure off AE and BF = 1½ in. Along CD measure CG and DH = 1 in. Along AD and BC measure AK and BL = 4 in. Join EK, KH, FL and LG with straight lines and join HG with a curved line, curving to 1 in. in the centre. Make a circle 2½ in. in diameter.

2. *The coronet.*—Make an oblong, 13 in. by 4 in., Fig. 2. Along each short side measure up 2 in., and from these points measure out ½ in. parallel to the base of the oblong. Join these points with a curved line which touches the top side of the oblong in the centre. Also join these two points to the ends of the base of the oblong with straight lines, Fig. 2. Connect the two corners of the base line with a curved line which curves to ½ in. in the centre. Divide each half of the upper curved line into three

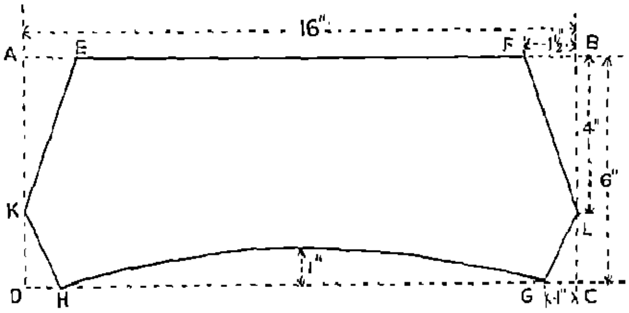


FIG. 1

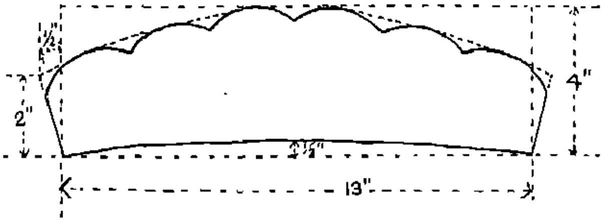


FIG. 2

equal parts. Mark down ¼ in. at each of these points and scallop the divisions, Fig. 2.

Requirements.—¼ yd. of 36 in. wide satin; ¼ yd. of soft net; ¾ yd. of Jap silk; 3¾ yd. of 1½ in. or 2 in. wide satin ribbon; knot of embroidery silk; ½ yd. of white silk baby ribbon.

Cutting out.—Lay the patterns on the material and allow ¼ in. turnings round the scalloped edge and the circle, and ½ in. turnings elsewhere. Cut out. Lay the patterns for the crown part only on the net and allow ½ in. turnings on all edges except EK and FL, where *no turnings are allowed.* Cut out. Cut out the circle on the pattern lines.

Making up.—

1. Place the net circle on the wrong side of the satin circle, fold over the turnings of the material and herring-bone them down to the net without letting the stitches show on the right side of the material, Fig. 3.

2. On the right side of the circle embroider a dainty design with the embroidery silk, Fig. 4.

3. Lay the net crown piece on the wrong side of the satin crown piece and tack them together, Fig. 5.

4. Join together on the wrong side the two shortest sides, KH and GL, with a *small running stitch, and press the turnings* flat on the net. Catch these down on the net only with herring-bone stitches.

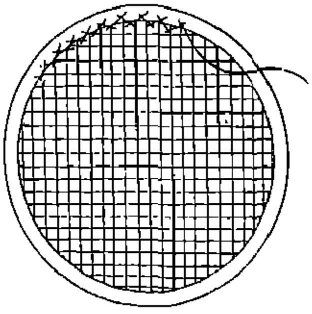


FIG. 3

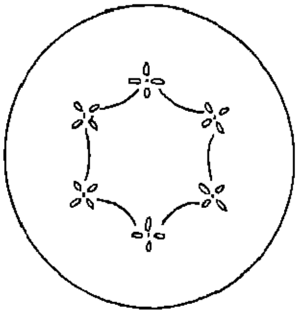


FIG. 4

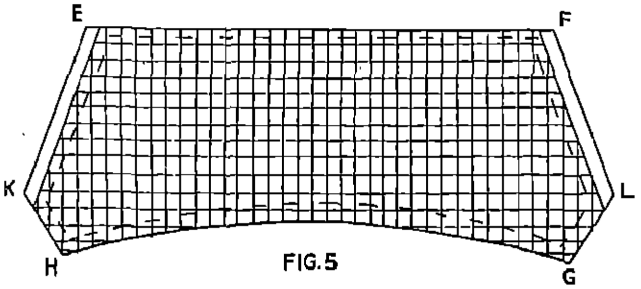
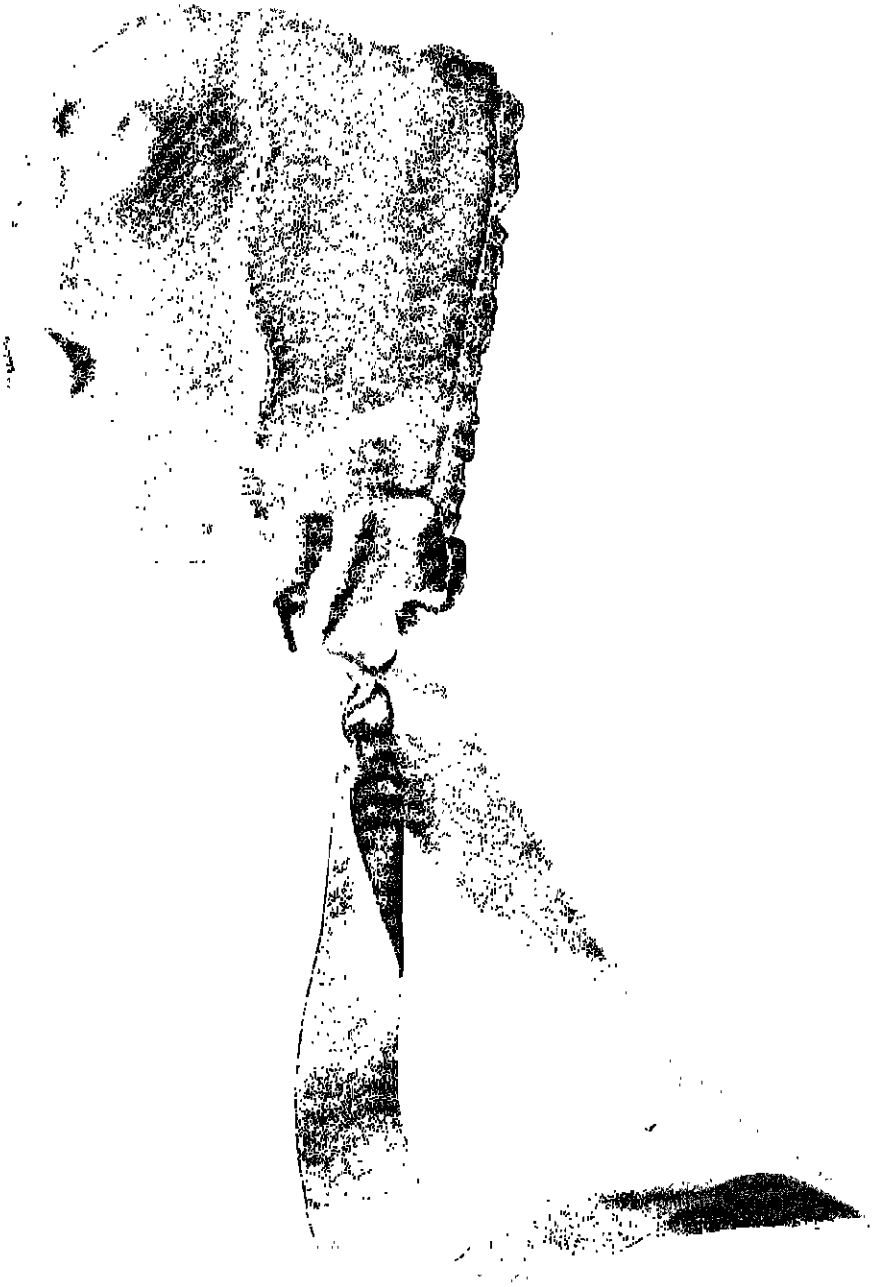


FIG. 5



Baby Girl's Best Bonnet

5. Herring-bone down to the net only the turnings EK and FL.

6. Put a gathering thread round GH ¼ in. away from the edge, and draw up to fit the circle.

7. Pin the circle on to the gathered part, tack down having the gathers even all round, and then feather-stitch down at the edge, Fig. 6.

8. Place the two pieces for the coronet, right side to right side, and join them along the two short sides and the scalloped side with a small running stitch.

9. Turn the coronet inside out and tack round the joined sides close to the edge to keep it flat.

10. Blanket-stitch with silk the scalloped edge, working three stitches in the same hole, Fig. 7.

11. Work a nice design on the coronet with embroidery silk, Fig. 7.

12. Place the under side of the open end of the coronet to the right side of the bonnet round the face, EF, and join with a running stitch. Flatten the turnings of this join back to the inside of the coronet, and hem the remaining open side of the coronet down on to the turnings.

13. Cutting the Jap silk on the cross, make three strips 2½ in. wide. Join these into one long piece. This is doubled over widthways and quilled, as follows:—

Turn the end of the silk inside the fold. Hold the silk in the right hand and quill with the left. First fold the silk backwards for ½ in. then forward ½ in., leaving ⅛ in. space between the two folds in the centre, Fig. 8. The pleats are held in position by means of a long back stitch ¼ in. from the lower edge.

14. This quilling is continued until the full length required for the front of the bonnet is obtained, and the end is turned inside the fold.

15. The quilling is placed inside the bonnet to show about ¼ in. outside the coronet and stitched to the bonnet without letting the stitches show on the outside, Fig. 9.

Lining the bonnet.—

1. Cut an oblong of Jap silk 5 in. by 4 in., and tack on the inside of the bonnet, through the net only over the back seam and circle of the bonnet. Turn in ¼ in. turnings at the bottom of the bonnet and slip-stitch it to cover the herring-bone stitches.

2. Cut a piece of Jap silk on the cross, 14 in. by 6 in., for the remainder of the lining. Along one of the long sides turn a ¼ in. hem to form a slot. Make a small buttonhole through one fold of the slot in the centre and thread the baby ribbon through.

3. Slip-stitch the lining in to cover the turnings of the quilling and also the sides of the bonnet, Fig. 10.

4. Draw up the baby ribbon to cover the edges of the oblong piece, tie in a bow and catch the slot down in several places, Fig. 10.

5. Fold lengthways a length of ribbon to fit round the back and side of the bonnet and tie-stitch it down here and there, Fig. 11.

6. Cut two satin ribbon strings each 22½ in. long, and stitch in position at the sides of the bonnet. Mitre the loose ends.

7. Make a looped rosette and stitch it over the ends of the strings at the sides of the bonnet. This completes the bonnet, Fig. 11.

A BABY BOY'S BEST HAT

Drafting the pattern.—

1. Make a circle 3 in. in diameter.
2. Make an oblong 20 in. by 6 in.
3. Make another oblong 18 in. by ½ in.

Requirements.—½ yd. of 30 in. wide satin material; 3¼ yd. of 2 in. wide satin ribbon; circle of wadding 3 in. in diameter; ¼ yd. of Jap silk for the lining; 1 yd. Valenciennes lace, ½ in. wide; knot of embroidery silk; ½ yd. of swansdown.

Cutting out.—Place the patterns on the satin material and allow turnings, ¼ in. round the bands and ½ in. elsewhere. Cut out.

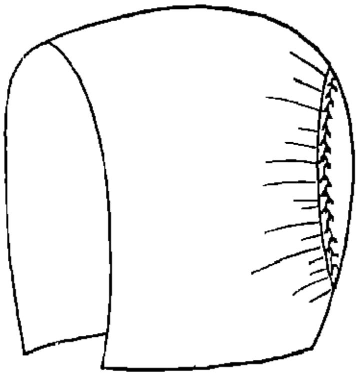


FIG. 6

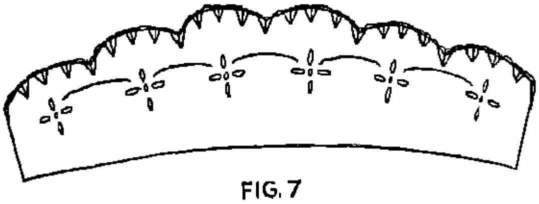


FIG. 7

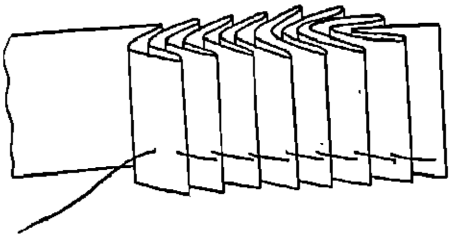


FIG. 8

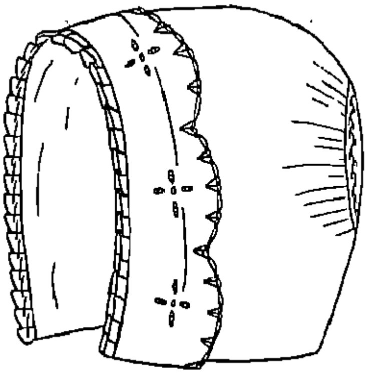
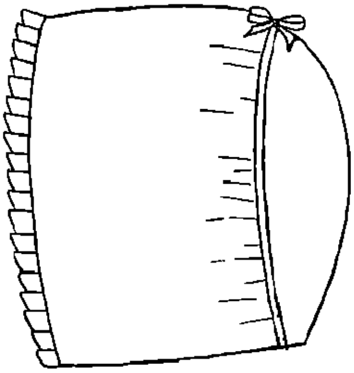


FIG. 9



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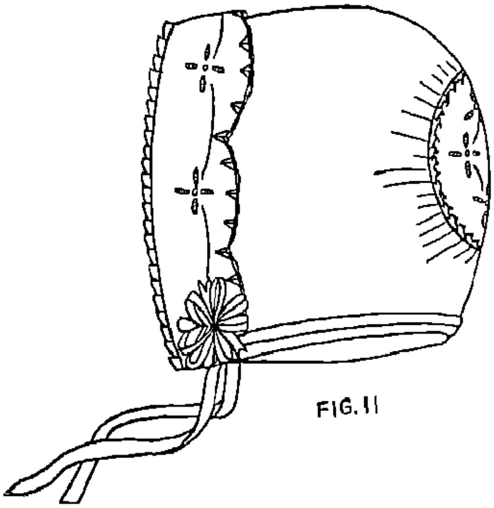


FIG. 11

A Baby Girl's Best Bonnet

Place the patterns of the large oblong and the circle on the Jap silk and allow ½ in. turnings. Cut out.

Making up.—

1. On the right side of the satin circle embroider a neat design round the centre, Fig. 1.

2. Place the wadding on the wrong side of the satin circle and catch the turnings of the satin over on to it, Fig. 2.

3. Join the crown piece on the wrong side to form a ring, and press the seam flat.

4. Along one edge put a gathering thread ¼ in. away from the edge, and draw it up to fit the circle.

5. Pin the circle on the right side over the gathers, having them arranged evenly. Tack it down and then feather-stitch it down at the edge, Fig. 3.

6. Join each of the bands together on the wrong side to form two separate rings, and press both seams flat.

7. Put a gathering thread through the lace and draw it up to fit the size of the bands.

8. Place the lace between the two bands, which fit right side to right side, having the straight edge of the lace to the edges of the bands.

9. Join all these three together with a small running stitch ¼ in. away from the edge, Fig. 4.

10. Turn the bands inside out so that the lace points outwards, and tack the bands just below the lace to keep them flat, Fig. 5.

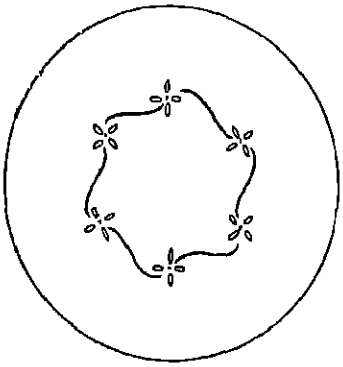


FIG. I

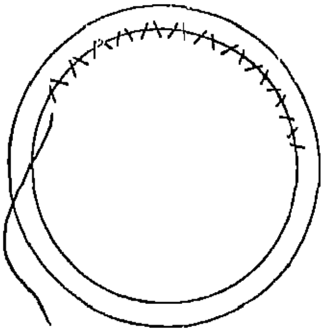


FIG. 2

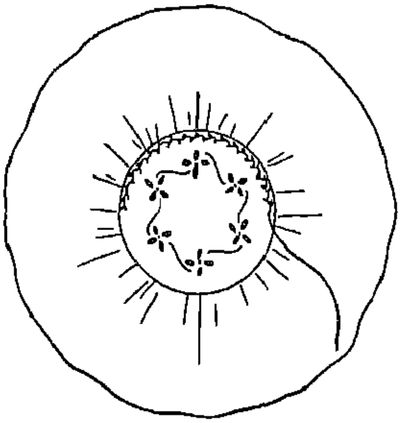


FIG. 3

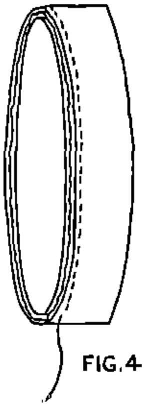


FIG. 4

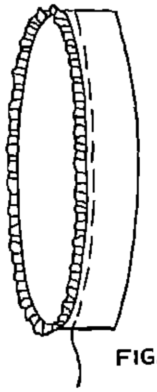


FIG. 5

11. Join the Jap silk lining in a ring and press the seam flat.

12. Put a gathering thread ¼ in. away from one edge of this lining.

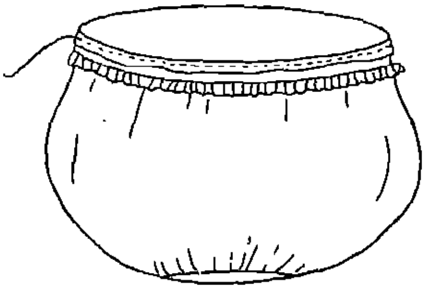


FIG. 6

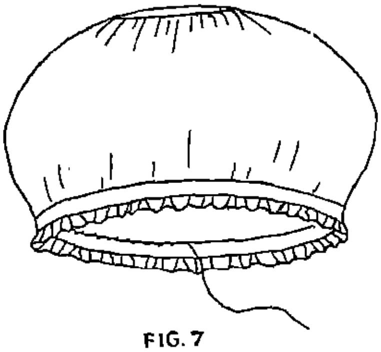


FIG. 7

13. Place the lining inside the hat, having the wrong side of the lining seam fitting to the wrong side of the satin seam, and the gathered edge to the circle.

14. Draw up the gathering thread to make it fit the circle, arrange the gathers evenly and catch them down to the turnings of the circle.

15. Place the remaining edges of the satin crown piece and lining crown piece together and put a gathering thread through them both.

16. This thread is drawn up to fit the band.

17. Place the band over the hat on the right side, arrange the gathers evenly and stitch the lower loose edge of the band to the gathered portion of the hat ¼ in. away from the edge, Fig. 6.

18. Turn the band completely over, then turn in the edge of the band ¼ in. and slip-stitch it inside the hat, Fig. 7.

19. Turn in the edge of the lining circle and place it over the circle of wadding. Slip-stitch it down.

Trimming the hat.—

1. Attach the swansdown over the band on the right side of the hat.

2. Cut two lengths of satin ribbon, each 22½ in. long, and stitch them neatly inside the hat at each side. (The join in the crown piece is the centre back.) Mitre the loose ends of the ribbon.

3. From the remainder of the ribbon make two looped rosettes and attach them in the swansdown at each side. This completes the hat, Fig. 8.

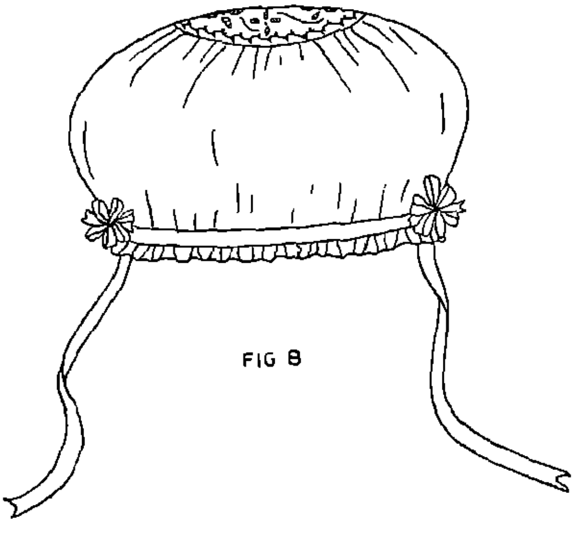


FIG 8

A GIRL'S SUNBONNET

Drafting the pattern.—

1. *The crown.*—Make a circle 14 in. in diameter. Cut away a section 2¾ in. wide from the circumference for the base of the bonnet. Carry each end of this line ½ in. outside the circumference of the circle, curving the circumference at each side to meet these points. Along the base, join these two points with a curved line, curving up to ½ in. at the centre, Fig. 1.

2. *The brim.*—Make an oblong 15 in. by 3 in. Along the top long side, from each corner measure 3 in. along the line. Down each short side, from the top, measure 2 in. Join these two points at each side with a curved line, Fig. 2.

3. *The crown band.*—Make an oblong 24 in. by 6 in.

4. *The curtain.*—Make an oblong 21 in. by 5½ in. Join the two top corners with a curved line, curving down to ⅜ in. at the centre. Measure along each short side from the bottom ¼ in. and join these two points with a curved line touching the base line of the oblong in the centre, Fig. 3.

Requirements.—Suitable materials are:—print, spotted muslin, plain or flowered voile, or organdie.

1 yd. of 36 in. wide material, or ¾ yd. 46 in. wide material; e.g., organdie; 4 yd. of cotton piping cord; knot of embroidery silk (for use if plain material is used); ⅛ yd. 27 in. wide leno (for stiffening the brim if voile is used). Stiff muslins do not require the brim to be interlined with leno, as the material is stiff enough to support itself. When using transparent material the cord should be dyed the same colour as the material.

Cutting out.—

1. Place the patterns on the material and cut out, allowing ½ in. turnings all round.

2. Cut two straight pieces 22½ in. long and 1½ in. wide for the strings.

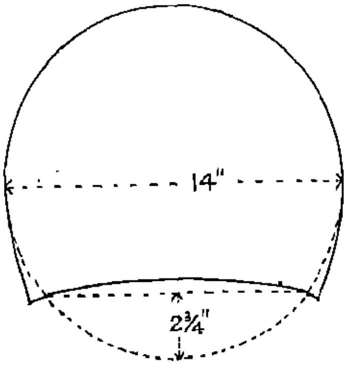


FIG. 1

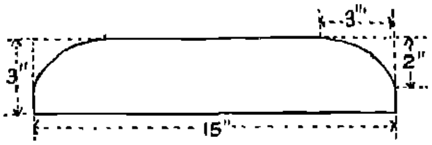


FIG. 2

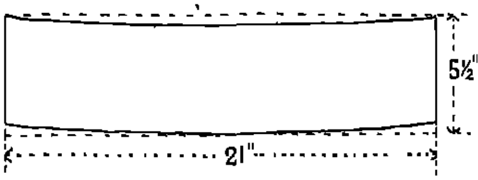


FIG. 3

Making up.—

1. *The brim.*—Cut a length of cord equa to the outer edge of the brim. Cover thi with a ¾ in. strip of the material left an tack it close to the cord, Fig. 4. With th cord facing the inside of the brim, place th covered strip to the outer edge of on material brim and tack underneath the corc

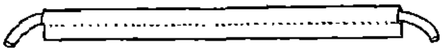


FIG. 4

Fig. 5. Place the outer edge of the second material brim to the outer edge of the first brim, having the covered cord between, and tack close to the cord, Fig. 5. These are all now joined together with a small running stitch. Cut the turnings close to the join, turn inside out, and tack the outer edge down to keep it flat having the piping cord standing out clear at the edge of the brim, Fig. 6. If desired, the brim may be embroidered, Fig. 6. Fasten the piping cord securely at each end. Fold over the double inside edge of the brim once on the right side of the brim and catch it down with a small running stitch. This is to avoid untidy edges showing when the bonnet is finished, Fig. 6.

2. *The crown band.*—Fold over one long edge of the crown band to form a hem $\frac{11}{12}$ in. wide. Catch this down with small running stitches. Insert a length of cord through the hem and place another running thread in the hem $\frac{1}{4}$ in. away from the first, having the cord in the slot so formed, Fig. 7. Make a tuck farther along the crown band similar in size to the hem, and having a length of cord inserted at the base, leaving a $\frac{1}{4}$ in. space between the top of this tuck and the hem, Fig. 7. Fold over a small turning along the remaining edge of the material and run a gathering thread, Fig. 7. Draw up these cords and gathering thread to fit the inner edge of the brim. Arrange the gathers evenly and set the first tuck just over the edge of the brim. Backstitch this through at the base of the cord, Fig. 8. Fasten the ends of the cord securely through the material. Fold over a small turning on the short sides of the crown band on the right side of the material and catch down with a running stitch.

3. *The crown.*—Fold the outer edge of the crown material over to form a hem $\frac{11}{12}$ in. wide, and sew down with a small running stitch, Fig. 9. Insert a length of cord and put in another running stitch, having the cord in the slot thus formed, Fig. 9. Draw up the cord to fit the inner edge of the

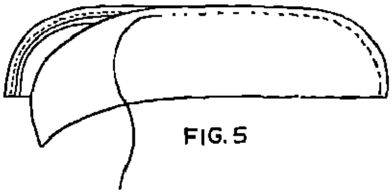


FIG. 5

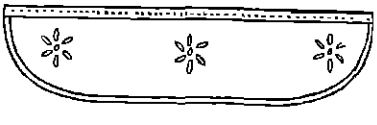
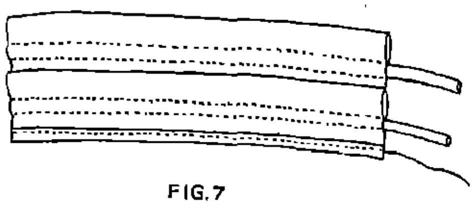


FIG. 6



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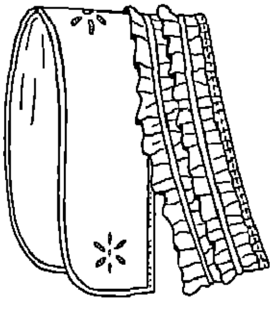


FIG. 8

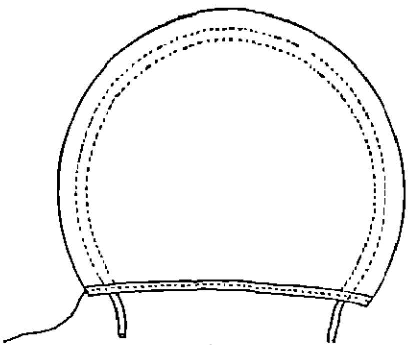


FIG 9

crown band, Fig. 10. Set it over the crown band, having the tuck ¼ in. away from the second piping of the crown band, Fig. 10. Closely stitch through at the base of the cord. Fold over once the base of the crown on the right side and catch down with a small running stitch. Draw this running thread up to make the base 7 in. long.

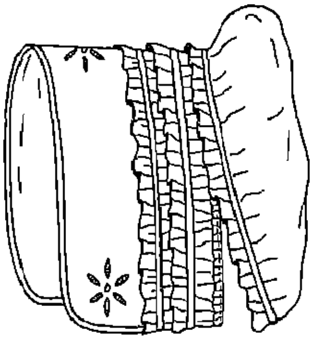


FIG. 10

4. *The curtain.*—Turn down three of the edges of the curtain to form a hem on the wrong side of the material and hem down or catch it down on the right side with a chain stitch, Fig. 11. Fold over the upper edge of the curtain to form a hem $\frac{11}{12}$ in. wide on the wrong side, Fig. 11. Insert the cord and place a running stitch ¼ in. away from the hem. The curtain may be embroidered if desired. Draw up the cord to fit the neck part of the crown, arrange the fullness, and back-stitch through at the base of the cord, Fig. 12. Turn a small hem all round the strings and hem down or catch them down with a chain stitch. Sew them neatly on the inside of the bonnet at each side of the curtain. This completes the bonnet, Fig. 12.

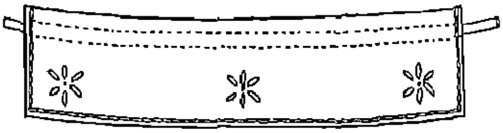


FIG. 11

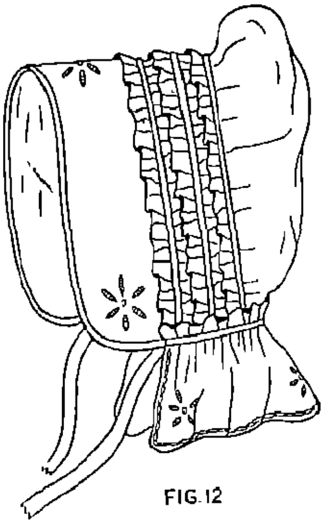


FIG. 12

A BOY'S HAT

Drafting the pattern.—

1. *The brim.*—Draw a circle 12 in. in diameter, and outside this draw another circle 16 in. in diameter, Fig. 1. From a point on the circumference of the inner circle measure 10 in. along the circumference at each side of the point, Fig. 1. Draw a

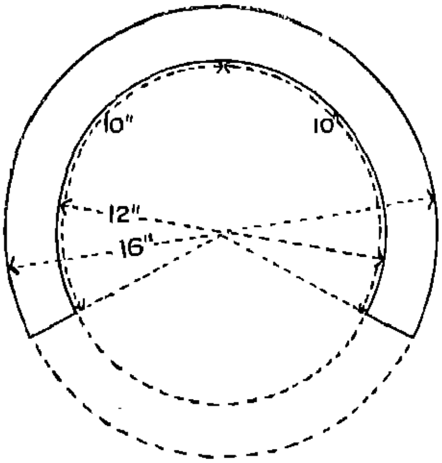
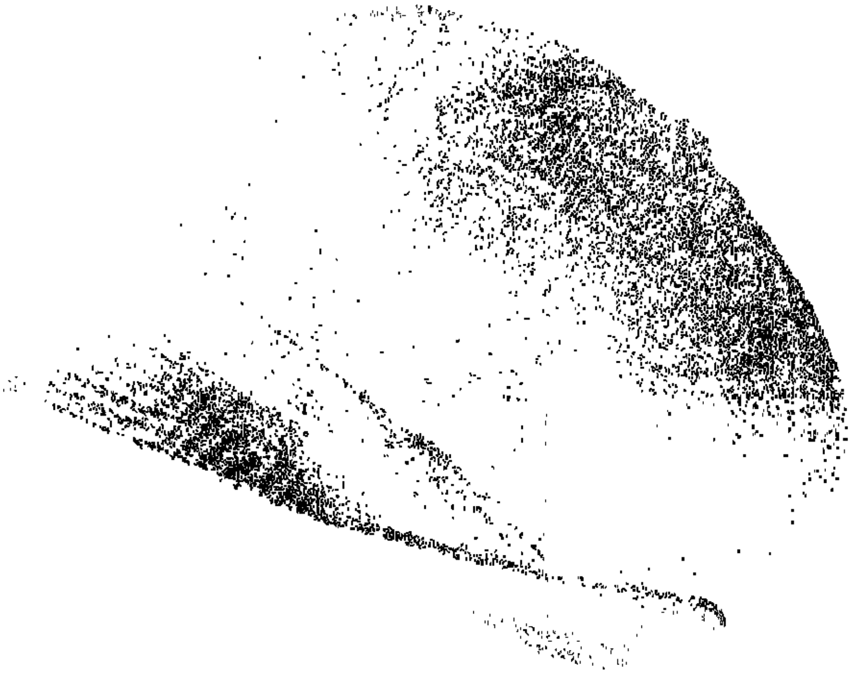
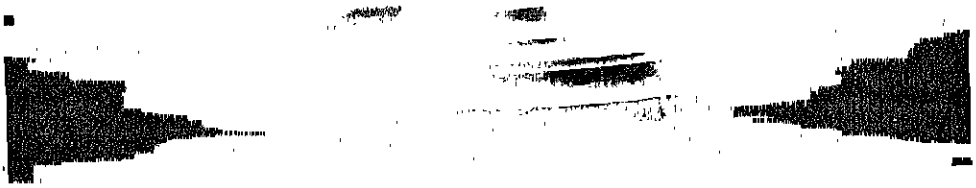


FIG. 1





Boy's Hat

line from each of these last two points to the centre of the circle and continue it from these two points to the outer circle, Fig. 1. The section of the two circles thus measured forms the brim.

2. *The crown.*—This consists of six similar sections. Draw a line AB, 3⅓ in. long. From the centre of this line draw upwards a perpendicular line CD, 7 in. long. Join D to A and D to B with curved lines, Fig. 2. The curve of the gore determines the final shape of the crown, and this can be varied according to choice.

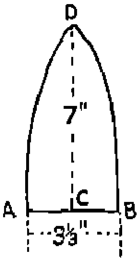


FIG 2

Requirements.—½ yd. of tweed; ½ yd. of leno or book muslin for interlining; ¼ yd. of polonaise for the lining.

Cutting out.—

1. *Material.*—Place the patterns of the brim and gore on the wrong side of the material as in Fig. 3, with the centre front of the brim on the cross of the material. Two brims and six gores must be marked out. Mark all round the patterns with chalk or pencil, as a guide for sewing, then allow turnings where shown in the diagram, and cut out.

2. *Leno.*—Six gores and one brim only must be cut out similar to the material. Mark out all round the patterns with chalk or pencil, and then allow turnings as in Fig. 3, except along the base of the gores where no turnings are allowed.

3. *Lining.*—Cut out six gores only. Allow turnings as in Fig. 3.

Making up.—

1. Place the leno brim to the wrong side of one of the material brims, and baste them together, Fig. 4.

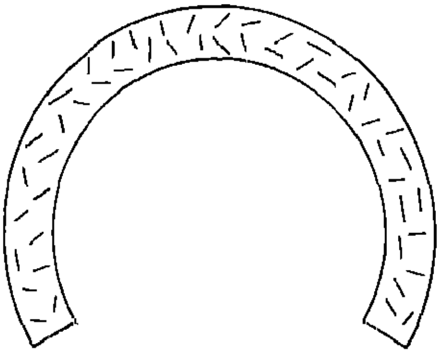


FIG. 4

2. Machine or back-stitch the short sides of the two brims together, thus forming a ring, and press the seam flat, Fig. 5.

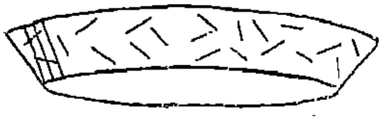


FIG. 5

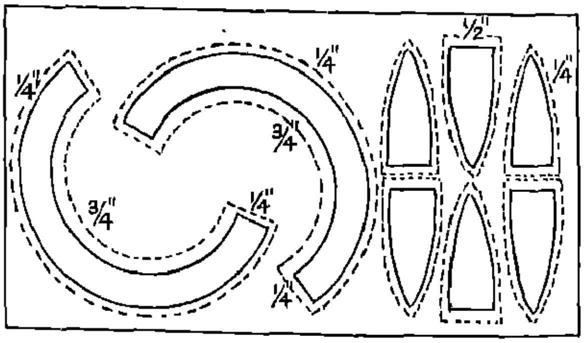


FIG. 3

3. Machine the short sides of the remaining material brim together and press the seam flat.

4. Place the right side of the two material brims together, laying the seam of one to the seam of the others and machine them along the outer edge on the pattern line, Fig. 6.

5. Notch the turnings round the head part of all three brims almost to the pattern line, the notches being ½ in. apart, Fig. 6.

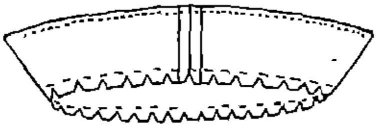


FIG. 6

6. Turn the brims inside out (the leno brim will now lie between the two tweed brims), and tack carefully round the outer edge to keep the seam flat.

7. Baste all the three brims together and machine-stitch round, beginning with the first row on the outer edge, and every other row ½ in. apart up to the head part, Fig. 7.

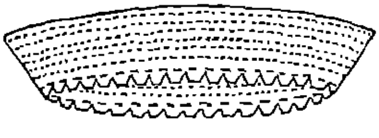


FIG. 7

8. Cut a strip 21 in. by 3 in. from the remaining leno. Join it in a circle 20 in. in circumference, and fold it lengthways in three, thus making a head band 20 in. by 1 in.

9. Using the joins as the centre back, place the notches of the brim under the head band and pin into position. Stitch these together with a long back stitch, the long stitches being over the notches, Fig. 8.

10. On the wrong side of each material gore, place a leno gore and baste each pair together. Machine-stitch them together ½ in. on the inside of the pattern line, all round except the base, Fig. 9.

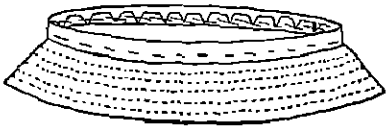


FIG. 8

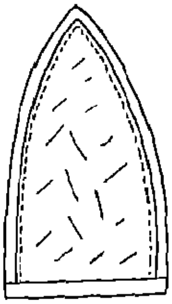


FIG. 9

11. Join the gores together in pairs on the wrong side, beginning at the apex of the gore each time, first tacking two gores together down one side only on the pattern line, and then machining them, Fig. 10.

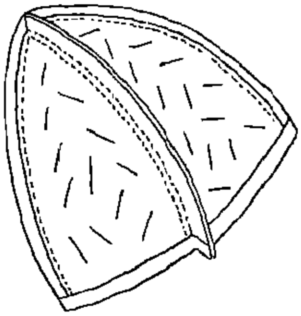


FIG. 10

12. Press all the seams out perfectly flat in order to get a good shape when the hat is finished.

13. Join the first pair of gores to the second pair, and then join the third pair, beginning at the apex of the gore each time. *N.B.*—The apexes of all the gores must join in one central point when all are machined

together, and care must be taken to get a good round shape when the crown is finished, Fig. 11.

14. When all the seams are pressed flat turn the crown inside out, and turn under and tack the ½ in. turnings at the base of the crown on the wrong side, Fig. 11.

15. Place the centre of one of the gores over the join of the head band, and work round, fitting the crown over the head band. Slip-stitch it into position, Fig. 12.

16. Cut a strip of tweed, 1 in. by 25 in.

17. Fold over the edges lengthways on the wrong side and machine down near the edge. Press flat, Fig. 13. Fold one end over to form a bow, Fig. 13.

18. Place this in position at the base of the crown, stitching the bow over the raw edges of the band. The bow must lie on the left side of the hat, Fig. 14.

19. Cover a small button mould with the tweed and stitch it in the centre of the crown, Fig. 14.

20. Remove all basting and tacking stitches.

21. Join the sections of the lining in the same manner as the material crown, and press the seams flat.

22. Slip it inside the hat, wrong side to wrong side, with the seams of the lining lying on the material seams, and with the central points fitting on the top of each other.

23. Turn inside the turnings at the base and slip-stitch the lining to the hat, Fig. 15.

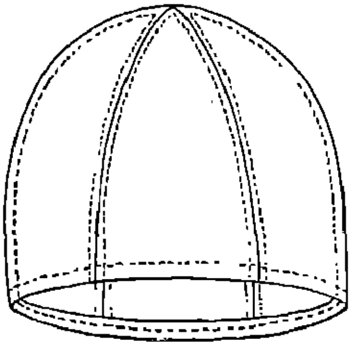


FIG. 11

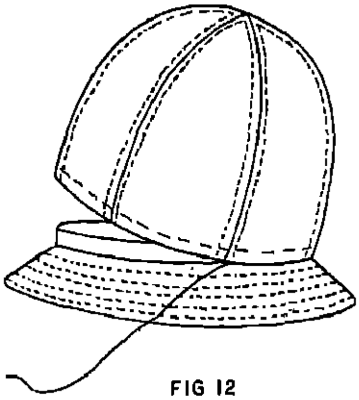


FIG 12

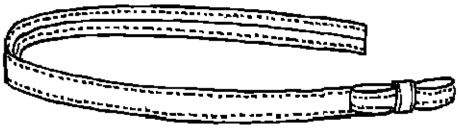


FIG. 13

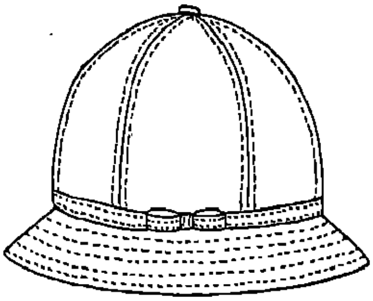


FIG. 14

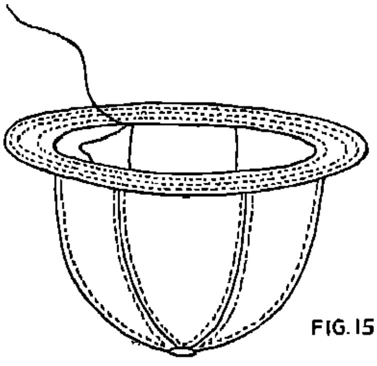


FIG. 15

The brim may be turned up all round or turned up at the back and down in front, Figs. 16 and 17.

For a summer hat, linen or poplin are most suitable materials to use.

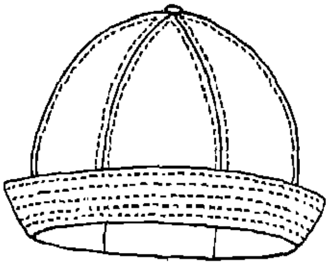


FIG. 16

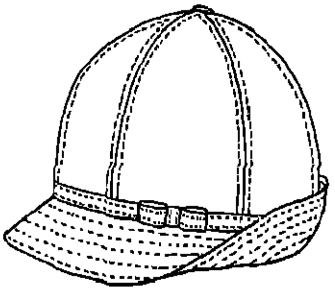


FIG. 17

A GIRL'S LIBERTY HAT

Drafting the pattern.—The only pattern required to be drafted is a circle, 3 in. in diameter.

Requirements.—1 yd. of pastel-shaded organdie; ⅛ yd. of another pastel shade of organdie for trimming; 5 yd. of piping cord dyed to match the organdie; 3 yd. of velvet baby ribbon.

Cutting out.—

1. Cut out one piece of material on the cross 35 in. long by 9 in. wide for the crown. Cut out another piece of material on the cross 42 in. long by 8 in. wide for the brim.

2. Using the circle pattern cut two circles in material, allowing ½ in. turnings all round.

3. Cut out one piece of material on the cross 21 in. by 6 in. for the lining.

Making up.—

1. *The crown.*—Make a ring of piping cord 20 in. in circumference. The cord must be joined by stoating the two ends together, not wrapping one end over the other. Join the strip of material for the crown in a ring and press the seam flat, Fig. 1. Turn one edge of the crown piece over the ring of cord on the wrong side of the material and place a small running stitch under it, Fig. 2. From this piping cord measure along the width of the crown piece 1 in., and mark with lillikin pins. Place another piping cord 20 in. in circumference on the wrong side of the material; fold the material over it on the right side and catch down with a small running stitch, Fig. 3. Similarly insert five more piping cords at intervals of 1 in. along the crown piece, the first two of these being 20 in. in circumference, the next 19 in., the

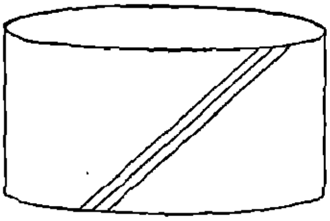


FIG. 1

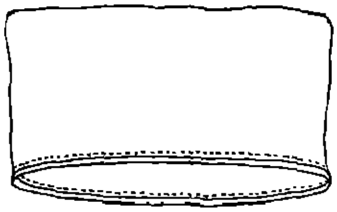
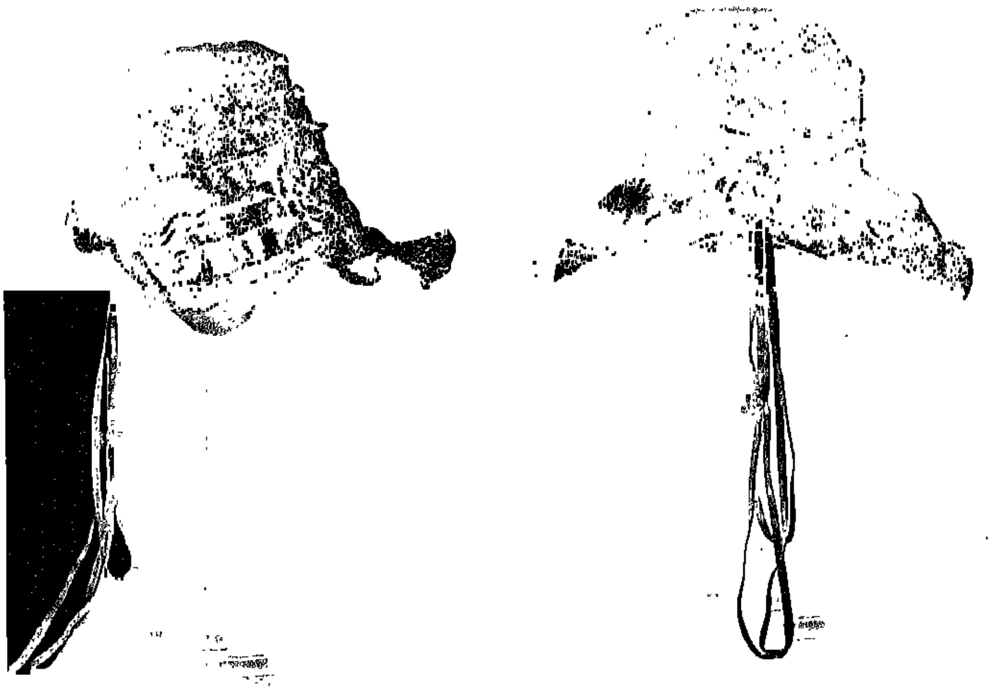


FIG 2



Girl's Liberty Hat

next 15 in., and the next 10 in., Fig. 3. Tack together the two circles of material. Place these under the crown piece and fit into position under the last piping cord. Backstitch them to the crown piece with a long back stitch at the base of the cord, the long stitch being on the wrong side of the hat.

2. *The brim.*—Join in a ring the piece of material for the brim and press the seam flat. Fold over the material lengthways, having the right side of the material outside, to form a double brim, Fig. 4. Measure 1 in. from the folded edge and put a gathering thread all round, drawing it up to 28 in. in circumference, Fig. 4. Make a ring of piping cord 28 in. in circumference. Place this between the folds of the brim, close to the gathering thread, and run another gathering thread underneath it, Fig. 4. From this cord measure 1 in. and put a gathering thread through the double brim, drawing it up to

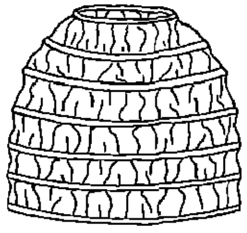


FIG. 3

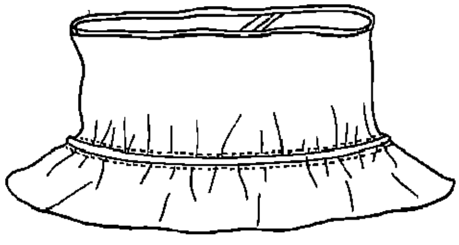


FIG. 4

26 in. in circumference. Close to this thread place a piping cord 26 in. in circumference, between the folds of the brim, and underneath it run another gathering thread, Fig. 5. From this cord measure 1 in. and put a gathering thread all round which is drawn up to 20 in. to fit the crown, Fig. 5.

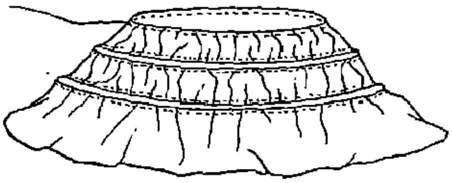


FIG. 5

Forming the hat.—

1. Place the head part of the brim under the base of the crown and pin it into position.
2. Stitch them together along the base of the crown cord with a long back stitch, the long stitch being inside the hat.
3. Trim all the edges of the turnings inside the hat to make them neat.

Trimming the hat.—Make a posy of flowers and leaves as follows:—

1. Cut a piece of organdie on the cross 6 in. by $\frac{3}{4}$ in.
2. Fold over lengthways and roll it up to form a rosebud, Fig. 6.

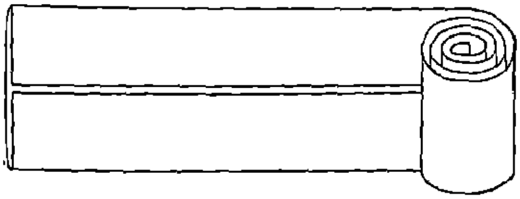


FIG. 6

3. Catch the end of each bud firmly.
4. Make in all fourteen of these buds, seven of one colour and seven of another.
5. Cut a 2 in. square of organdie and fold it diagonally.
6. Fold it over again as in Fig. 7.
7. Put a running thread at the base.
8. Gather the thread up tightly, end off, and cut it level at the base to form a leaf, Fig. 8.
9. Make thirty-six of these leaves.
10. Cut a circle of double material $\frac{3}{4}$ in. in diameter.
11. Round the outside edge of the circle place twelve leaves, each touching one another, and sew to the foundation with a long back stitch, Fig. 9.
12. Inside these leaves place another six leaves in the same manner, Fig. 9.
13. Arrange six rosebuds, three of each colour, in the centre of the leaves and stitch neatly at the base, Fig. 10.
14. Make another posy of rosebuds and leaves similar to the first.
15. Place a piece of the velvet ribbon round the base of the crown, letting the join lie at the right side front of the hat. Stitch neatly to the hat.
16. Over this join place a posy, and stitch neatly, Fig. 11.
17. Turn up the brim at the centre back and stitch it to the crown.
18. Loop the remaining ribbon into two loops, one 6 in. and the other 9 in. long, having two loose strings 18 in. and 14 in. long.
19. Attach these strings to where the brim is caught up, and over it place another posy, Fig. 12.
20. Catch the strings loosely together half way down with the remaining two rosebuds, Fig. 12.
21. If preferred, the loops may be omitted and a bow made with the velvet ribbon instead, according to the prevailing fashion.

Lining the hat.—

1. Join the piece of material for the lining in a ring 20 in. in circumference, and press the seam flat.
2. Turn one edge over to form a small turn on the wrong side and put a gathering thread through.
3. Draw this up to fit the crown tip; arrange the gathers evenly and catch it neatly to the turnings.
4. Turn inside the remaining edge of the lining to fit the base of the crown, and slip-stitch it into position.

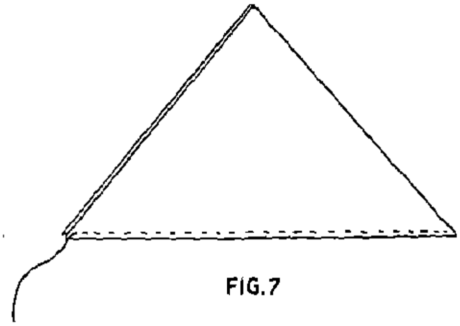


FIG. 7

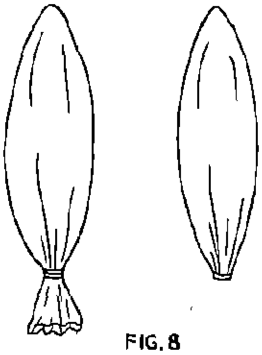


FIG. 8

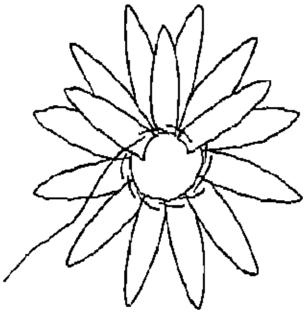


FIG. 9

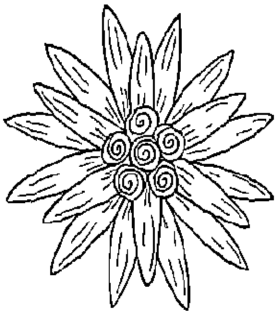


FIG. 10

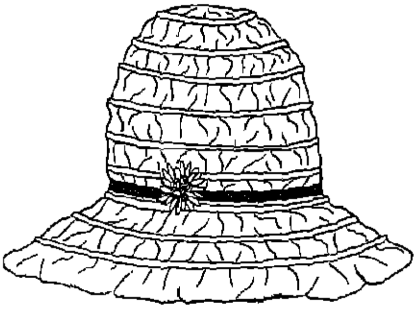


FIG. 11

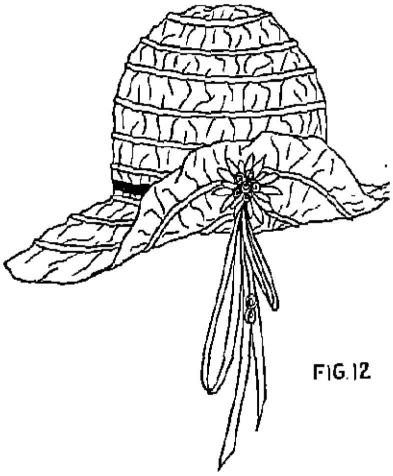


FIG. 12

A Girl's Liberty Hat

A GIRL'S SCHOOL CAP

Style 1

Drafting the pattern.—

1. *The crown piece.*—Make an oval 13 in. by 12 in.

2. *The brim.*—Draw an oblong ABCD, 11¾ in. by 2 in. From A and B measure along AB, 2 in. From A and B measure along AD and BC, 1 in. Join these two points at each side with a curved line, Fig. 1, p. 376.

3. *The band.*—For the canvas draw an oblong 22 in. by 1¾ in.

For the lining draw an oblong 22 in. by 4 in.

Requirements.—½ yd. of velour cloth in navy blue, brown or green; ¼ yd. of sateen the same colour as the material; ⅛ yd. of stiff canvas; four very small button moulds.

Cutting out.—Place the patterns on the material, sateen and canvas, and allow ½ in. turnings on all edges in the material and sateen, and on the straight edges of the brim only and short edges of the band in canvas. The oval piece must be placed on the cross of the material. Two brims are cut out in the material, sateen and canvas.

Making up.—

1. Join the canvas band to form a ring, and press the seam flat. The join forms the centre back of the cap.

2. Divide the ring up into four equal parts and mark with pins.

3. Divide the crown piece into four equal parts and mark with pins.

4. Place the pins of the crown to the pins of the band and pin them in position under the top of the band. The long part of the oval fits from front to back.

5. The surplus material in each quarter is box-pleated evenly on to the band, Fig. 2.

6. Catch the crown to the band with a long back stitch.

7. Baste the canvas brims on to the wrong side of the material brims, Fig. 3.

8. Place the right side of the sateen brims to the right side of the material brims and tack them together round the outer edge.

9. Machine the brims round the outer edge.

10. Remove the tackings and turn the brims inside out. Tack closely round the outer edge and baste the two brims.

11. Machine the brims round the outside edge and run four other rows of machining at even distances along the brim, Fig. 4.

12. Remove all basting stitches.

13. Place one of the brims round the front of the cap with the inside edge of the brim fitting under the canvas crown band, and having the sateen side uppermost, Fig. 5.

14. Tack this in position.

15. Place the remaining brim round the back of the cap in a similar manner, so that the round edges of the back brim overlap the round edges of the front brim at the right and left sides, Fig. 6.

16. Tack this in position.

17. Machine the brims to the canvas band.

18. Join the material band to form a ring and press the seam flat.

19. Turn over the edges ½ in. on the wrong side and press them flat.

20. Slip this band over the crown, having the right side outside, and fit it into position over the canvas band.

21. Machine this at each long side of the band and machine four more rows at even distances between them.

22. Cut two small pieces of material, 3 in. by ¾ in.

23. Make two small bands by turning in the edges all round, folding each piece lengthways and machining them flat.

24. Cover four button moulds with the material.

25. Turn up the brims of the cap to lie over the crown band, Fig. 7.

26. Place a small band at each side where the brims overlap and catch them down at each side with a button, Fig. 7.

27. Join the sateen band for the lining into a ring and press the seam flat.

28. Along one edge turn a hem on the wrong side, and machine.

29. Turn in the remaining edge once, pin round the head part of the cap and slip-stitch it in position. This completes the cap, Fig. 7.

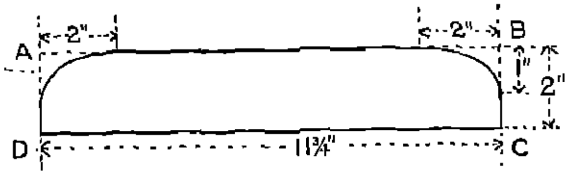


FIG. 1

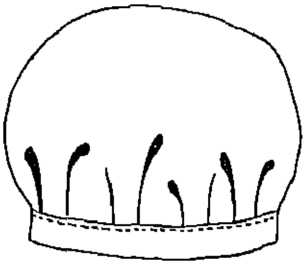


FIG. 2

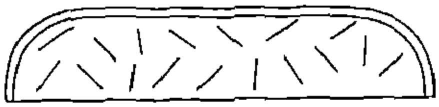


FIG. 3

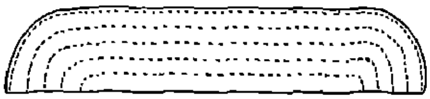


FIG. 4

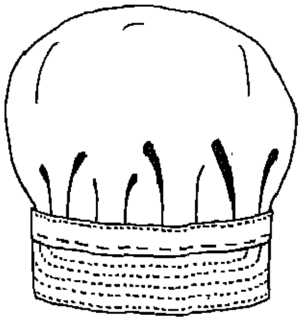


FIG. 5

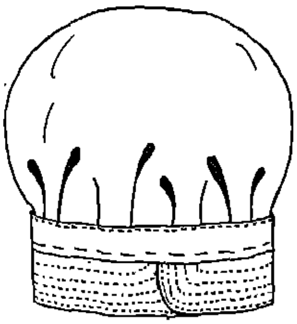


FIG. 6

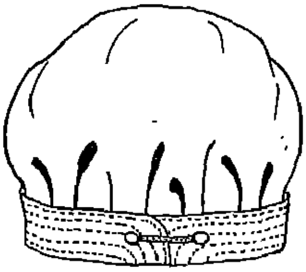


FIG. 7

A Girl's School Cap—Style 1

A GIRL'S SCHOOL CAP

STYLE 2

Drafting the pattern.—

1. *The crown piece.*—Make an oblong 14 in. by 15 in.

2. *The brim.*—Make an oblong 22 in. by 3 in.

3. *The crown band.*—Make an oblong 22 in. by 2¾ in.

Requirements.—½ yd. of velour cloth in navy blue, brown or green; ¼ yd. of sateen the same colour as the material; ⅞ yd. of stiff canvas; two button moulds.

Cutting out.—Place the patterns on the material and allow ½ in. turnings (the crown piece and the brim, and the crown band).

Place the brim and crown band patterns on the sateen and cut out, allowing ½ in. turnings.

Place the crown band on the canvas and allow ½ in. turnings on the short sides only.

Making up.—

1. Join the canvas band to form a ring, and press the seam flat. The join denotes the centre back of the cap.

2. Divide the band into four equal parts and mark with pins.

3. Fold over the crown piece lengthways, having the wrong side uppermost, and machine or back-stitch the sides together, Fig. 1.

4. Turn the crown piece inside out and tack the seams to keep them flat.

5. Pin the crown piece under the canvas band with the joins fitting to the pins marking the sides.

6. The surplus material at the front and back can either be darted or put in a pleat at the right and left side front, and right and left side back, Fig. 2.

7. The crown piece is stitched to the canvas band with a long back stitch, Fig. 2.

8. Join the sateen brim in a ring and press the seam flat.

9. Join the material brim in a ring and press the seam flat.

10. Place the two right sides of the material and sateen brims together and machine round one edge, Fig. 3, p. 378.

11. Turn the brims inside out, tack round the join, and baste the two brims together.

12. Machine round the edge, and then run four other rows of machine stitching at even distances along the brim. Remove the basting stitches, Fig. 4, p. 378.

13. Place the inside edge of the brim under the base of the canvas band, fitting the join to the back of the crown and having the sateen uppermost.

14. Stitch them together with a long back stitch, Fig. 5, p. 378.

15. Join the material band in a ring and press the seam flat.

16. Turn over each long edge ½ in. on the wrong side and press them flat.

17. Slip this band over the crown having

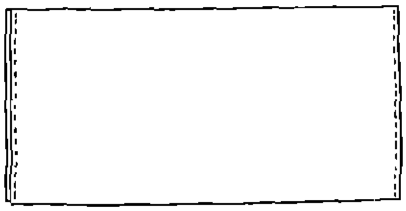


FIG. 1

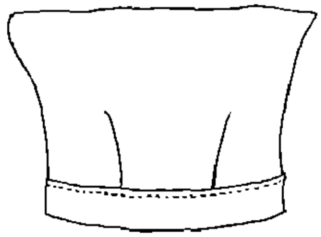


FIG 2

the right side outside, and tack it in position over the canvas band.

18. Prepare the sateen band in the same way as the material band, and tack it in position on the under side of the canvas band on the inside of the cap.

19. Machine these three bands together first along the outside edges, and then put three more rows at even distances, Fig. 6.

20. Cover the two button moulds with material.

21. Turn up the brim of the cap to fit flat to the crown band.

22. Pull down the corners of the crown piece to cover about 1 in. of the brim, and catch them to the brim with a button at each side, Fig. 7.

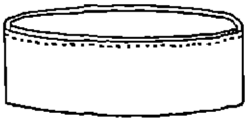


FIG. 3

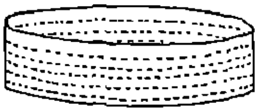


FIG. 4

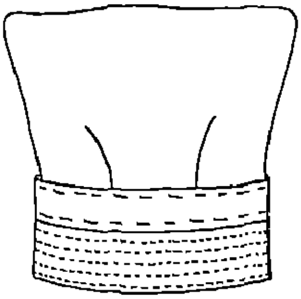


FIG. 5

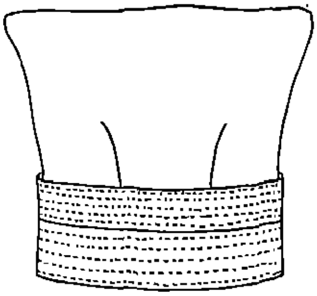


FIG. 6

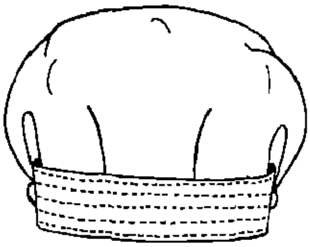


FIG. 7

A Girl's School Cap—Style 2

A GIRL'S SCHOOL CAP

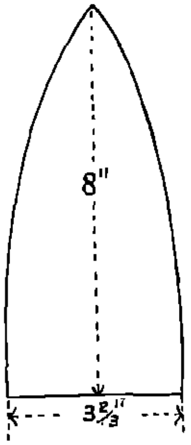


FIG. 1

STYLE 3

Drafting the pattern.—

1. *The crown section.*—Draw a line 3⅔ in. long and from the centre of this line draw upwards a perpendicular line 8 in. long. From the apex of this line draw curved lines to each end of the base, Fig. 1.

2. *The back brim.*—Make an oblong, ABCD, 14 in. by 2½ in. From A and B measure along AB, 3 in. From these points curve to D and C respectively, Fig. 2.

3. *The front brim or neb.*—Make a semicircle with a radius of 6 in. From the centre of this arc measure 5½ in. on each side of the circumference. Also from the centre of the arc draw upwards a vertical line 2 in. long. From the end of the vertical line draw a curved line to the points on each side of the arc, Fig. 3.

Requirements.—½ yd. of velour cloth in navy blue, brown or green; ⅓ yd. of sateen the same colour as the material; ⅛ yd. of soft canvas.

Cutting out.—Place the patterns on the material and sateen and allow turnings where shown in Figs. 4 and 5, p. 380. Cut out.

Making up.—

1. Place the right side of the material back brim to the right side of the sateen brim and

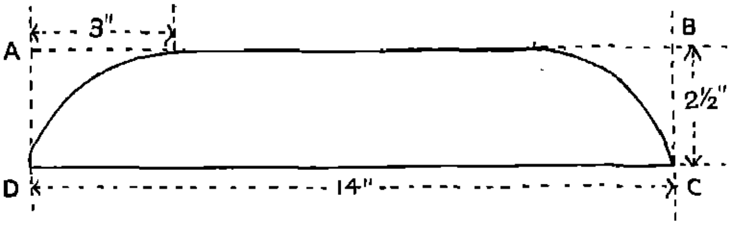


FIG. 2

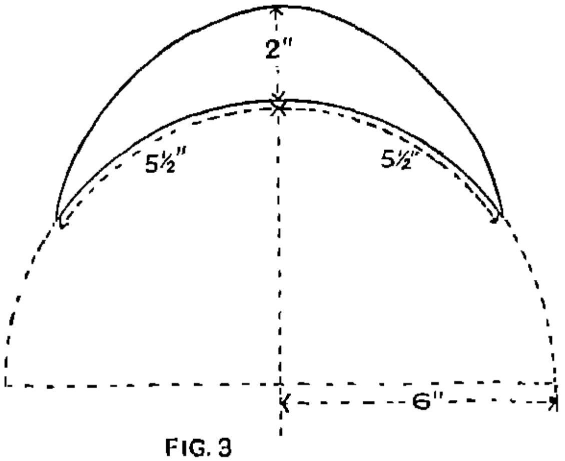


FIG. 3

machine them together round the outer edge, Fig. 6.

2. Turn the brims inside out, machine round the outer edge, baste them together, and run four more rows of machine stitching at even distances on the brim. Remove the basting stitches, Fig. 7.

3. From the canvas cut out a strip 23 in. long and 2 in. wide.

4. Join this strip to make a ring 22 in. in circumference. Fold it lengthways in two to form a band 1 in. wide. The join denotes the centre back of the cap.

5. Place the centre of the inside edge of

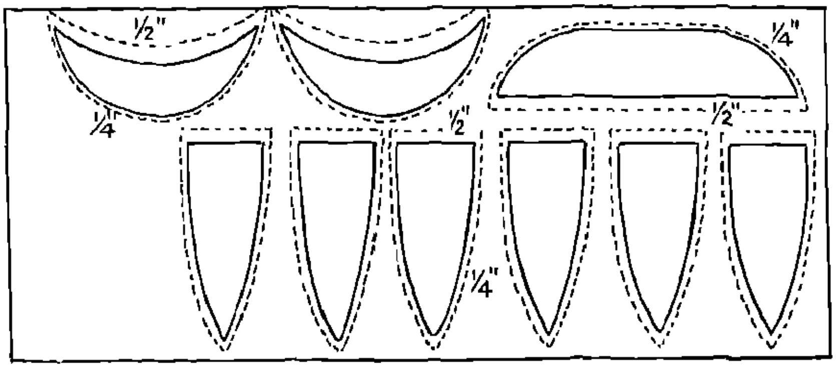


FIG 4

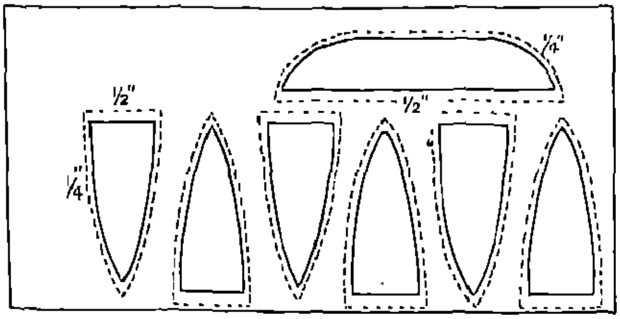


FIG. 5

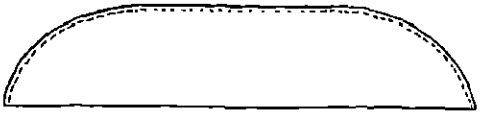


FIG. 6

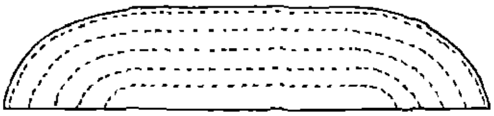


FIG. 7

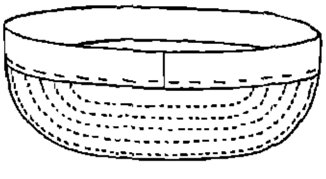


FIG. 8

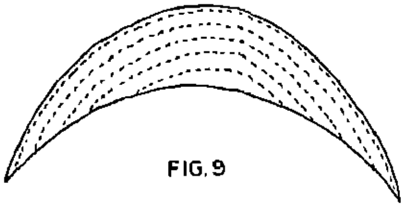


FIG. 9

the back brim to the join of the band, and fit it under the band. Stitch it in position with a long back stitch, Fig. 8.

6. Place the two pieces for the neb together, right side to right side, and machine them round the outer edge.

7. Turn them inside out, baste, and *machine them at the edge. Run four more* rows of machine stitching at even distances, *Fig. 9.* Remove the basting stitches.

8. Place the centre of the inside edge of the neb to the centre front of the band and fit it under the band.

9. Stitch it in position with a long back stitch, Fig. 10.

10. Join the gores in pairs, beginning at the apex of the gores each time, and press the seams open.

11. Join the three pairs together to form the crown, taking care that the apexes meet in one central point, Fig. 11.

12. Turn the base of the crown under on the wrong side for ½ in. and tack it down, Fig. 11.

13. Place the centre of the base of one gore to the centre front of the brim, and fit the crown over the crown band.

14. Machine-stitch it in position at the base of the crown, Fig. 12.

15. *Turn up the back brim to fit flat to* the crown, Fig. 13.

16. Cut a piece of material *9 in. by 1 in.*

17. Fold over both long edges and machine-stitch down.

18. Fix one end of the band under each end of the back brim having the band lying along the front base of the crown, Fig. 13.

19. Join the lining up in the same manner as the material crown and press the seams open.

20. Place the lining in the crown of the cap, having the seams lying over the seams of the material and the tips of the gores fitting to the tips of the material gores. Slip-stitch it in position, Fig. 13.

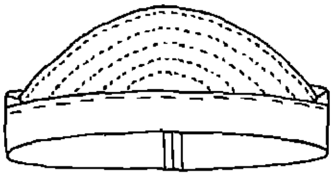


FIG. 10

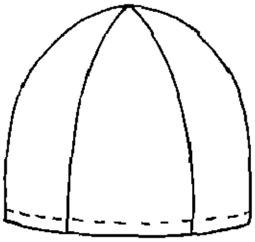


FIG. 11

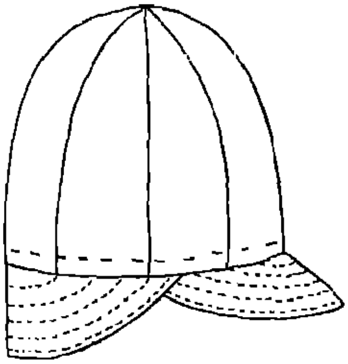


FIG. 12

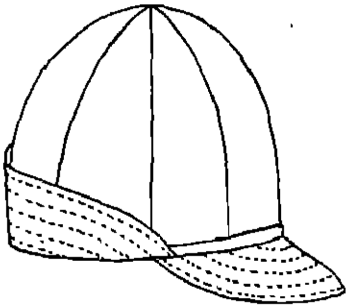


FIG. 13

A Girl's School Cap—Style 3

LITTLE GIRLS' FROCKS

These may be made up in many pretty and varied styles, and are very simply made by adapting the tunic or bodice blocks to suit the required style. Fig. 2 shows a pretty little frock, the pattern of which is obtained by the adaption of the tunic pattern.

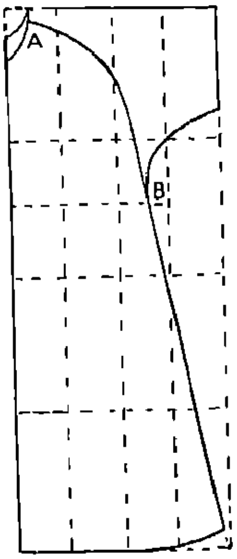


FIG. 1

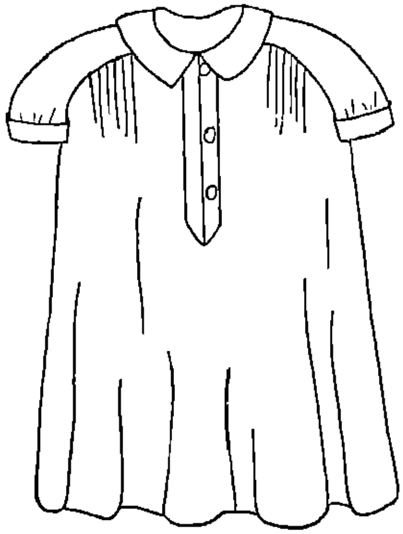


FIG 2

Measurements required.—As for drafting a tunic pattern, Fig. 1.

Drafting the pattern.—

1. Draw a line AB on the tunic pattern as in Fig. 1. Cut along this line so that a short raglan sleeve pattern is obtained.
2. Draft a simple cuff and a Peter Pan collar.

Requirements.—Twice the length, plus turnings, and hem, of thin fabric with a floral pattern; ¼ to ½ yd. of plain material.

Cutting out.—

1. Cut a double collar and double cuffs out of the plain material.
2. Cut out the back and front portions with the pattern laid to the fold of the material, allowing sufficient material to be tucked to fit the curve of the sleeve.
3. Cut out the sleeves from the remainder of the material between the curved portions of the front and back. Allow ½ in. turning all round the patterns except at the hem, where 2 in. to 3 in. are allowed.

Making up.—

1. Face the opening with a crossway strip of plain material.
2. Pin-tuck the front and back to fit the shoulder curves of the sleeves.
3. Turn under the curved edges of each sleeve, place in position over the front and back, and work two rows of machine stitching ¼ in. apart, or attach with decorative stitchery.

4. Fold the frock along the shoulder lines and join the under-arm seams.

5. Turn up the hem, set on the collar and cuffs, and fasten with small loops and buttons.

Figs. 3, 4, 5 and 6, show little frocks adapted from the bodice pattern with short set-in sleeves and illustrating the application of smocking or honeycombing. In Fig. 5 a narrow crossway strip of material is attached to the collar and sleeves by faggot stitch.

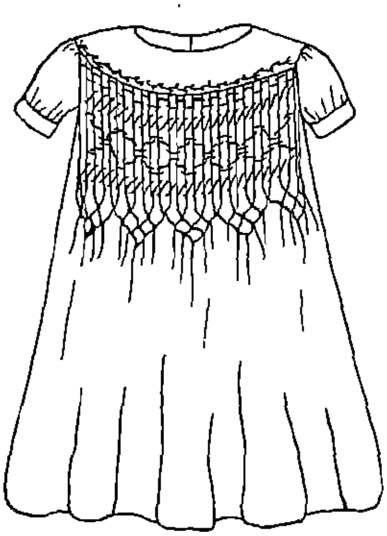


FIG. 3

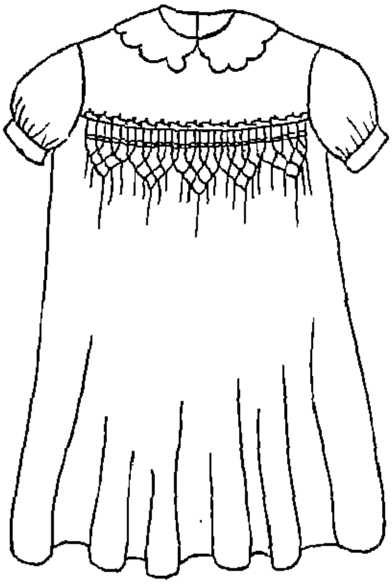


FIG. 4

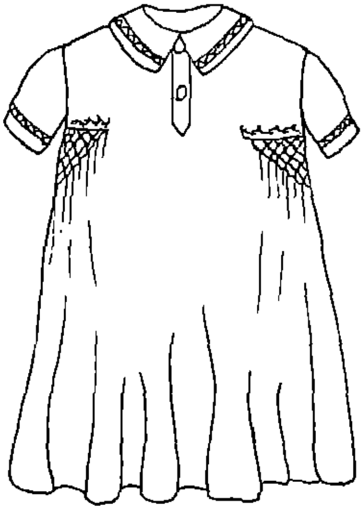


FIG. 5

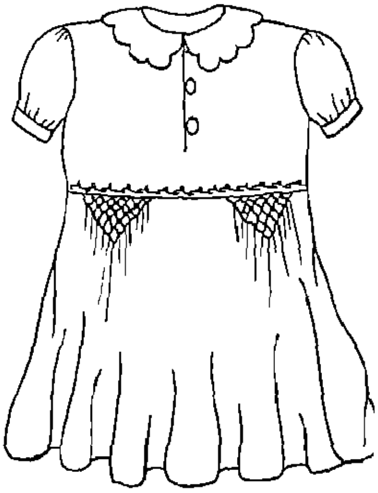


FIG. 6

LITTLE BOYS' SUITS

These may consist of a combination suit of a blouse and knickers joined together; a tunic suit; or a blouse and knickers suit.

Measurements required.—

1. As for the children's bodice pattern.
2. As for the children's knicker pattern.

Drafting the pattern.—

1. Adapt the bodice pattern to suit the style of blouse or tunic required; e.g., if a saddle or shoulder yoke is required as in Figs. 4 and 5.
2. Draft a sleeve pattern and adapt it to suit the length of sleeve required.
3. Draft the knicker pattern as in Fig. 1. This differs slightly from the girls' knicker pattern as boys' garments are more closely fitting than girls' knickers would be, Fig. 1.

COMBINATION SUIT

Requirements.—Any kind of washing material; e.g., gingham, tobralco, in contrasting shades of the same material 36 in. wide; e.g., beige and brown, ½ yd. of beige and ¾ yd. of brown. More material will be necessary if long sleeves are required.

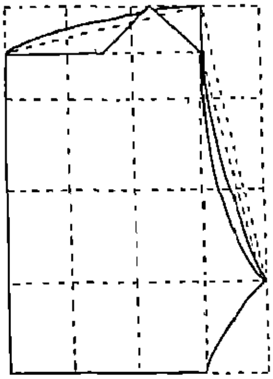


FIG. 1

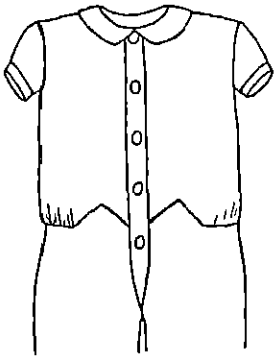


FIG. 2

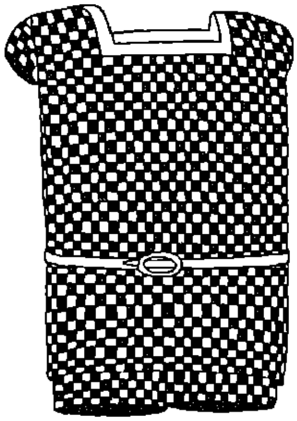


FIG. 3

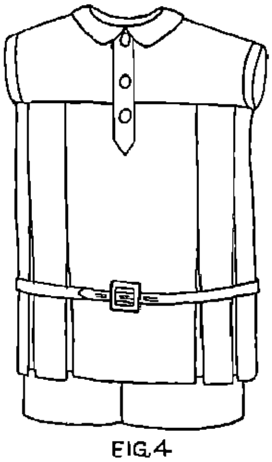


FIG. 4

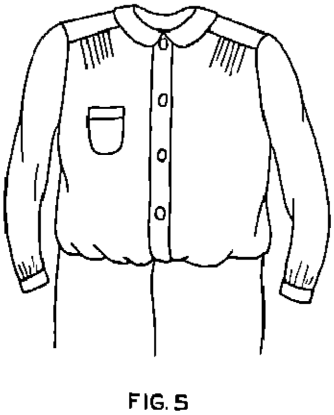


FIG. 5

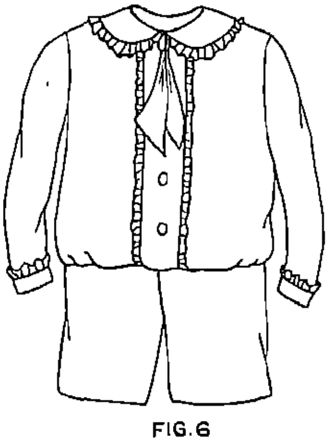


FIG. 6

Cutting out.—

1. Using the knicker pattern, cut out in the brown material two fronts and two backs, each front having a Vandyked line as shown by the lines in the draft.

2. Cut a double collar and double cuffs from the brown material.

3. *Cut out from the beige material the back* bodice, the pattern being laid to the fold of the material; two fronts with the lower edge shaped to fit the Vandyke of the knickers, and the under-arm sloped to allow more material for gathering the blouse slightly at the sides; and two sleeves.

4. Allow ½ in. turnings on all edges except at the knees, where 1½ in. turnings must be left for a hem.

Making up.—

1. Take each leg of the knickers separately and join the front and back portions. Turn a 1 in. hem at the bottom.

2. Placing short seam to short seam, join the two legs together along the centre back edges, continuing round to the front for 1 in. past the top of the inner leg seams. This leaves most of the centre front open for fastening.

3. Join the blouse seams, and make and set in the sleeves.

4. Gather the waist of the blouse a little at each side, turn under the top edge of the knickers, and machine them in position over the blouse.

5. Neaten the opening down the left centre front with a strip of brown material to represent a box-pleat, the lower end of which is pointed. Machine-stitch all round the strapping close to the edge.

6. Make the collar and the cuffs and attach them to the blouse. Fasten with buttons, Fig. 2.

Figs. 3 and 4 show two different styles of tunic suits, and Figs. 5 and 6 show two styles of blouse suits. When the knickers are not joined to the blouse they may be held with elastic, or the top edge may be faced and buttonholes worked, which button to a small bodice. Elastic is also inserted at the waist of the blouses to give a pouched effect.

SLEEPING SUITS

The pattern for a sleeping suit is easily obtained from the combination and adaptation of the bodice and knicker patterns. They may be made to enclose the feet or to allow the feet to be free.

Fig. 1 shows how to obtain the pattern for either style.

Measurements required.—Length from waist to ankle.

Drafting the pattern.—The main part of the pattern is drafted in one piece by placing

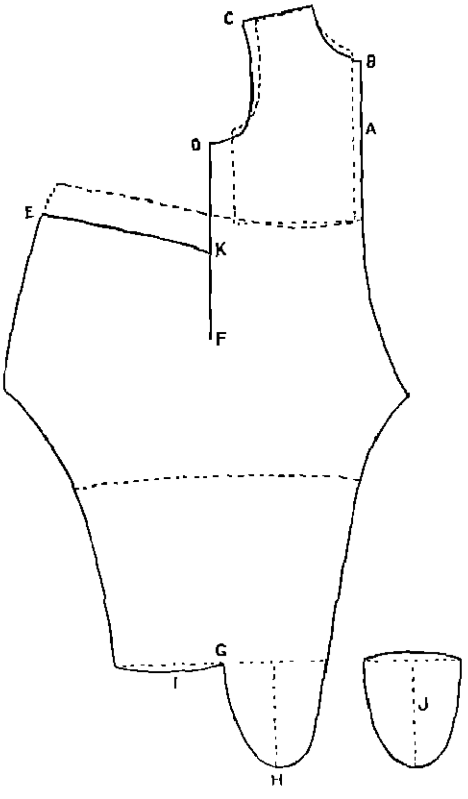


FIG. 1

the front bodice block to the front of the knicker pattern, as shown by the dotted lines in Fig. 1, and making the following alterations:—

1. Allow ½ in. for wrap-over on the front of the bodice, A.

2. Lower the neck line 1 in., B.

3. Make the shoulder 1 in. wider for easy fitting, C.

4. Lower the armhole, 1 in., D.

5. Lower the back of the knickers about 2 in., E.

6. Draw the under-arm line to meet the back of the knickers, and extend it for one-third the length of the knickers for the side opening, F.

7. Extend the knicker leg to the required measurement, narrowing it to two-thirds the width of the knickers at the bottom, G.

8. If the suit must enclose the feet, extend the front half of the pattern only to equal the length of the foot from ankle to toe, and curve round for the toes, H. Curve the back half of the pattern at the ankle to ¾ in. at the centre, I. For the sole, cut a pattern similar in shape to the foot, curving the heel end outwards ¾ in., J.

9. In the back pattern make the shoulder 1 in. wider; lower the armhole 1 in. and lengthen the pattern so that the under-arm is the same length as the front under-arm, K.

10. Draft a sleeve pattern to fit seam to seam, and draft a simple collar.

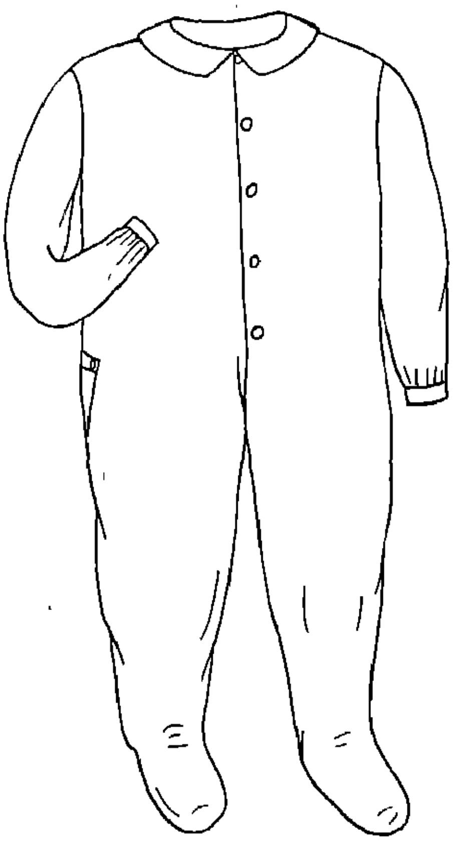


FIG. 2

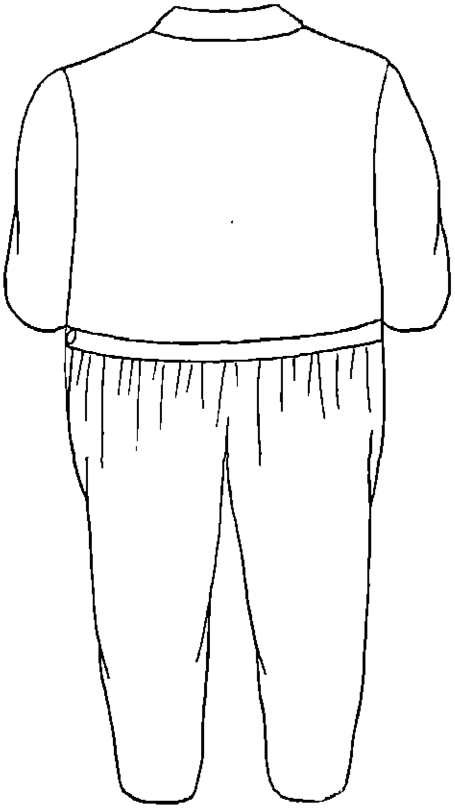
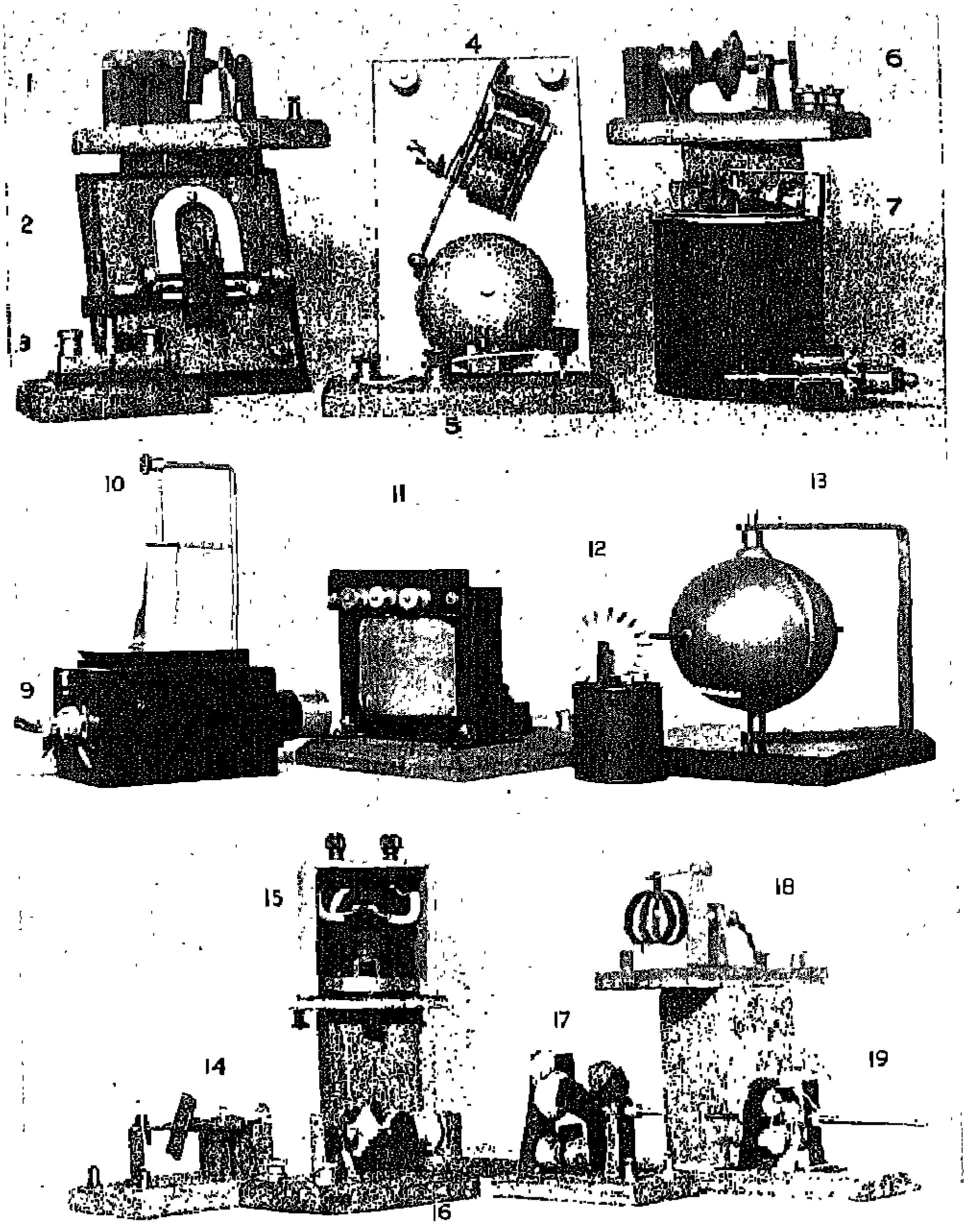


FIG. 3

HANDICRAFT IN SCIENCE



Handicraft in Science—Typical Models

1. Electric motor with unwound armature.
2. Barlow's wheel.
3. A plug key.
4. Electric bell—gong raised from sheet aluminium.
5. Simple type of morse key.
6. Electric motor with two-pole wound armature.
7. Steam turbine with horizontal rotor.
8. Armature built from stampings.
9. Lamphouse for microprojector.
10. Pulsating iron rod in a solenoid.
11. Mains transformer.
12. Steam turbine with vertical rotor and safety valve.
13. Reaction steam turbine (Hero's engine).
14. Another view of No. 1.
15. Moving coil galvanometer.
16. Another view of No. 6.
17. Experimental three-pole electric motor.
18. Flashing light operated by a bimetallic coil.
19. Three-pole enclosed field motor in course of construction.

THE SCOPE AND ORGANISATION OF SCIENCE HANDICRAFT

Introduction.—A consideration of science handicraft may be developed along two lines, each with its own end but employing the underlying principles common to both. The aim of one is to enable teachers of science to make and repair apparatus, while the other is concerned with the introduction of simple apparatus and model making as part of the practical work of the class. The former is of particular importance now that so many teachers of science give to their work the stamp of their own individuality, and therefore feel the need for items of apparatus not generally available.

With regard to the second line of development there is a growing feeling that further opportunities for constructional work should be given, particularly to boys[1] in the later years of their school life. Science handicraft offers such an opportunity at the present time, and may later be found to meet a pressing need for more practical work when the school leaving age is raised.

It is generally agreed that the making of a working model in which a young person has a real and lively interest, evokes that continuity of effort which is a potent form of discipline, enlivens whatever theory lies behind the work he is doing, and gives an opportunity for the development of original thinking in the solution of new problems. When the model is being made by a group, it can also give exercise to his power of collaboration, showing him the need for good workmanship on his part so that the aim of the group may be successful.

It is not suggested that science handicraft should be introduced at all ages, and at all grades of brightness. The work demands the exercise of a fair measure of intelligence such as is generally found in "A" and "B" classes, experience having shown that the best results are obtained from the most intelligent. The too rapid introduction of such work into the curriculum, and its extension to "C" and even "D" classes at too high a level of complexity, have led to disappointment and sometimes to the abandonment of the work. Teachers starting such a course would, therefore, be well advised to begin in a small way with a good class, finding out for themselves just how much they can expect the boys to do. They should also keep open the possibility of adjusting the range and difficulty of the models within the course.

A good deal of useful work may be done with the less intelligent pupils, but they require more "spoon-feeding," and the opportunities for both individual contributions and the exercise of ingenuity must then be neglected. The problem of supervising the work also becomes acute when every stage in the design and construction has to be closely controlled by the teacher. The ideal towards which one hopes to progress is to discuss the problem briefly with the pupil, to suggest in broad outline one method of attacking it, if necessary, and then to leave the boy to work out the details for himself. This can be approached very nearly if the work, beginning on very simple lines, is developed progressively to higher grades of difficulty.

An example of the degrees of difficulty which influence the choice of models is given in the following series of contact keys.

Contact keys.—In the successive development of a contact key (Fig. 1), the simple key, A, is made of brass strips of about 24 gauge. The flexible strip is dented with a round-pointed punch to give a small area of contact, and the knob is made from a metal button soldered above the dent, and filled in with sealing wax.

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[1] Any reference to "boys" in these pages is merely for simplicity of expression; there is no reason why girls should not attempt this kind of work.

Fig. 1 B shows a more elaborate form, capable of taking heavier currents. The insulating knob is a short length of ebonite or bakelite rod, drilled and tapped to take a screw which, at its lower end, is equipped with silver solder contact points. These are shown in section in Fig. 1 C. The end of a length of 22 gauge silver solder wire is sweated into a drilled recess at the end of the screw, zinc chloride being used as a flux and thoroughly washed away afterwards. It is then cut to leave about $\frac{1}{16}$ in. projecting to be filed flat. The contact plate, which is sweated to the "cheese-head" of the screw, is easily made by fusing the wire to a bead and then flattening the bead with light hammer blows (for details see *Soldering*). These contacts do not readily corrode.

The further development (Fig. 2 A), is a simple Morse key. In addition to the "front stop" and "bridge" contacts, an

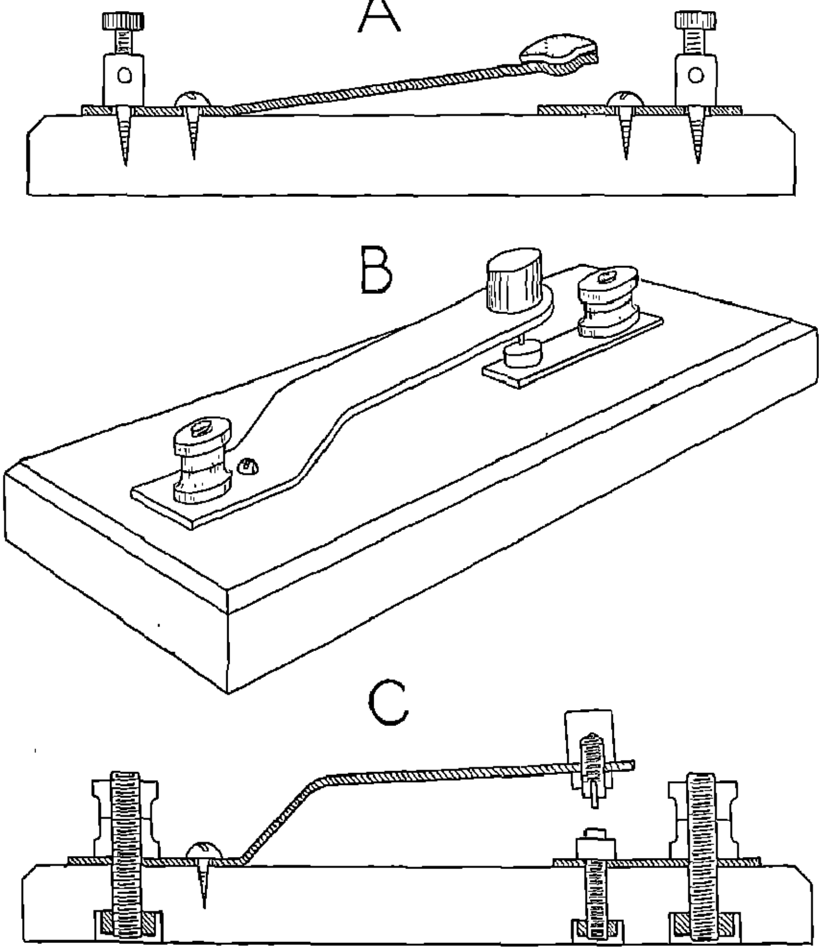

FIG. 1. SUCCESSIVE DEVELOPMENTS OF A CONTACT KEY

A. A simple key made from brass strip, shown in section.
B. A similar principle, but introducing silver solder contact points, and recessed baseboard to allow the use of nuts and bolts.
C. A section through the key shown at B.

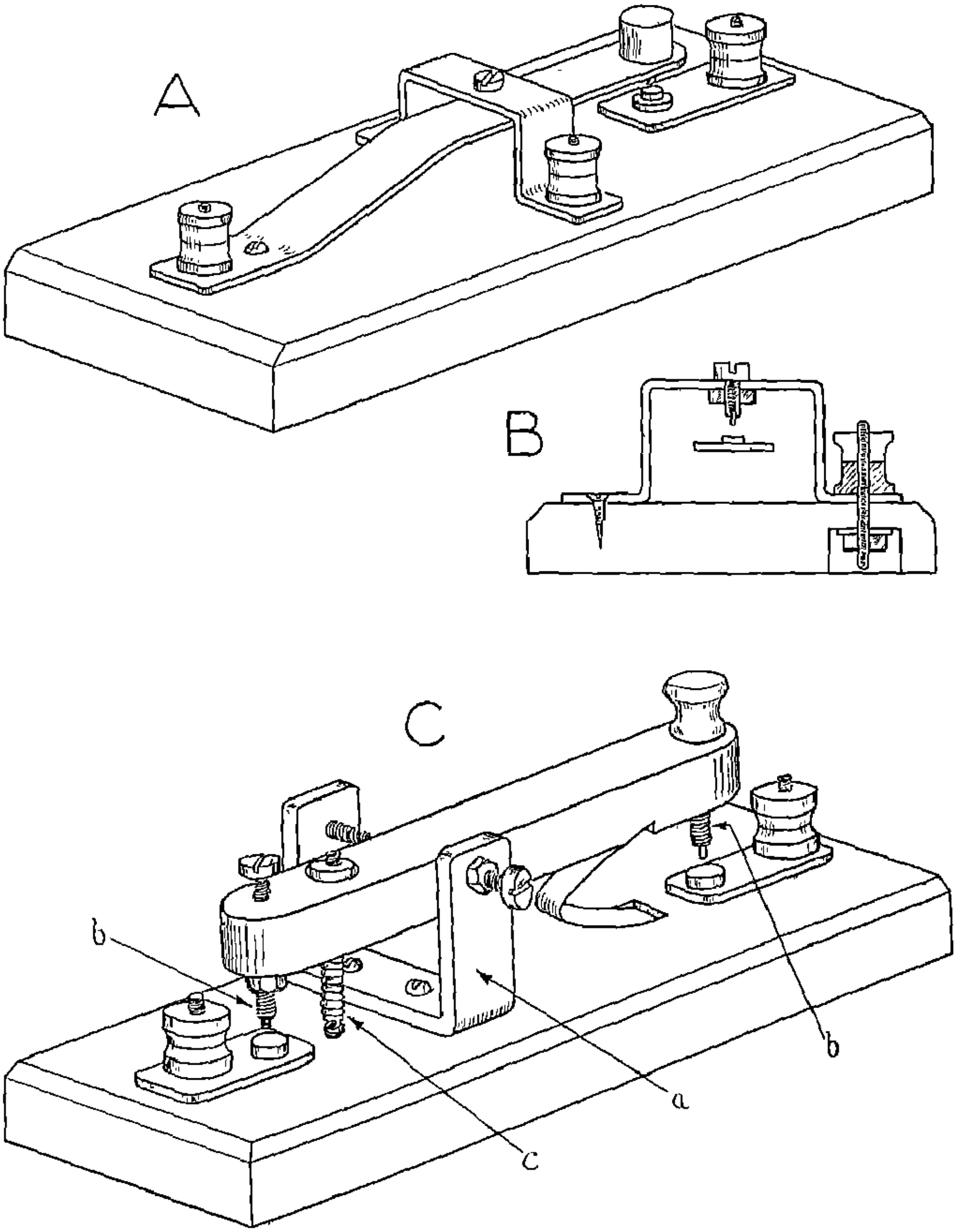

FIG. 2. TWO MORSE KEYS

A. Built from brass strip.
B. Section of stirrup forming the back stop.
C. A more conventional type, showing two methods of springing.

- *a*. ½ in. by ⅛ in. brass bar.
- *b*. Silver solder points.
- *c*. Spring.

A third terminal, not shown in the diagram, is connected to the bridge *a*.

adjustable "back stop" is provided by the metal strip, shown as a section in Fig. 2 B, which passes over the middle of the flexible arm.

Fig. 2 C shows the details of a more conventional *form* of Morse key. The movable arm is a brass bar of ½ in. by ⅜ in. section. It is supported by a steel axle soldered into position, and pointed at each end to fit into drilled recesses in two screws. The latter are supported by a bridge (*a*) of ½ in. by ⅛ in. brass bar, bent without annealing, *and are held by* locknuts. Silver solder points (*b*) as in Fig. 1 B, are incorporated. The spring (*c*) is wound from steel wire, the adjustment being provided by the threaded rod which is free to move up and down in its hole. In this model the connections to the three terminals are by stout copper wire laid in grooves in the underside of the baseboard and bedded in melted paraffin wax. The ends of the wires are soldered to the lower ends of the terminals or bolts.

Fig. 2 C shows, also, an alternative method of springing. A length of clockspring is bent to a Vee form, with its ends housed in slots, one in the arm and the other in the baseboard.

Owing to the variety of needs, opportunity and ability one meets in schools, it is not desirable that we should outline a course in science *handicraft* for senior schools. Each teacher will wish to compile his own. We therefore intend, primarily, to deal with the basic processes and mechanisms involved in the construction of apparatus, to give a brief account of the materials employed and the uses for which they are appropriate, and to provide examples of a few models over a range of difficulty. Thus the science master will find information which may be of value to him, assisting him to design and construct apparatus, and to pass on instruction to the members of a class if he wishes to do so.

One need hardly stress how important it is that the master should first make the model,—or at least visualise very carefully every stage in its production. Unforeseen difficulties occurring occasionally may have considerable educative value, but if they appear too frequently the interest may be destroyed. Reference to an actual model may help a beginner to a clear idea of his problem, and provide him with a standard of craftsmanship at which to aim, and if possible to surpass. Mere copying is, of course, not advocated.

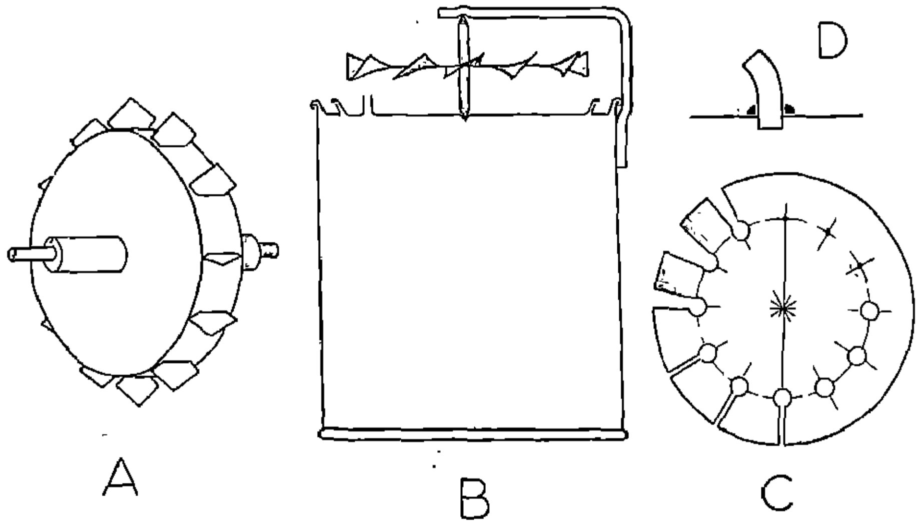

FIG. 3. DEVELOPMENT OF A MODEL FROM AN IMPROVISATION

A. The improvisation; a cork and glass tube mounted on a knitting needle. Squares of tinplate as blades.
B. The model partly sectioned.
C. The rotor, marked out, drilled, and the blades cut.
D. A deflecting jet.

Model making in the science lesson.—"It is essential to recognise that science and handicraft are separate subjects, each with its own tradition. This does not, however, imply that they have no common ground." Within that common field one should try to preserve, as far as possible, the ideals of each, though that is difficult in situations where time is limited. The result is that in science model making the teacher often feels that he can ill afford the time for good *craftsmanship, preferring* rather to concentrate on the illustration of scientific principles by rapid improvisations, and by models whose sole merit is that they work. The value of such models is freely admitted, but they hardly lie within the field of science handicraft.

None the less, these improvisations may suggest, and serve as an incentive for, the construction of more permanent models which might be designed to introduce a *further principle.*

An example of such treatment is suggested in Fig. 3.

A cork supported by a knitting needle running in a glass tube has squares of tinplate pushed in round its circumference to serve as paddle blades, Fig. 3 A. It is driven by an air or steam jet directed by a glass tube or mouth blowpipe held in a retort stand. This is the improvisation. In the first model (Fig. 3 B) a canister with a *spring lid* acts as a boiler. The jet may be either a hole punched with a small nail from below, or a $\frac{1}{8}$ in. bent copper tube, Fig. 3 D. The suspension of the rotor is by points running in centrepunch dents, one in the lid and the other in a brass strip bent to shape and soldered to the side of the canister. The rotor (Fig. 3 C) is made as shown from tinplate. Cuts are made with shears, from the edge into the holes previously drilled, and each section is turned through about 45°. The pointed axle is passed through a central hole and soldered.

The idea may be developed further, as in Branca's engine, by mounting the rotor with its blades turned through 90° this

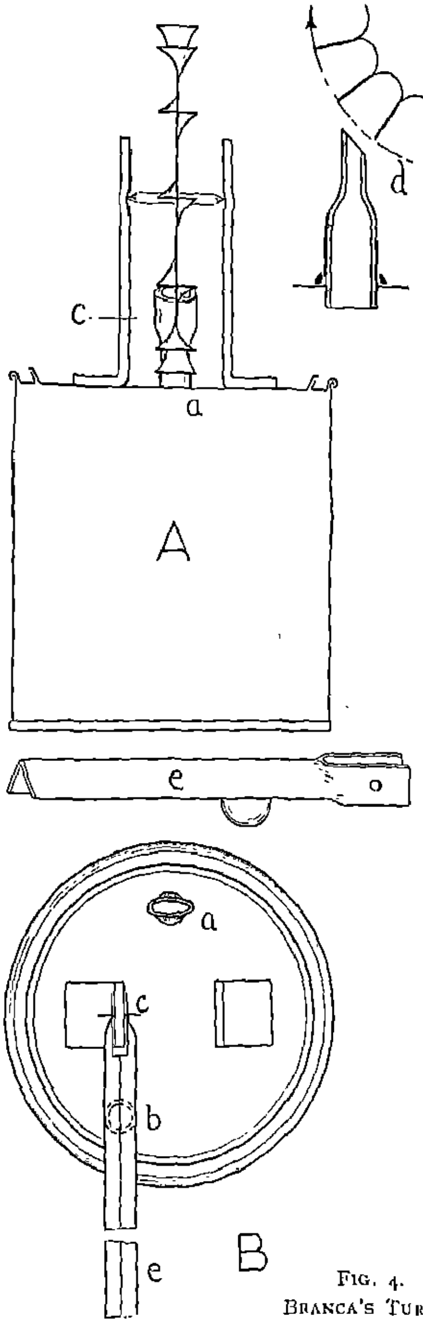

FIG. 4.
BRANCA'S TURBINE

A. In elevation.
B. Plan of the lid assembly:—
  a. Position of the jet.
  b. Filler hole and valve.
  c. Safety valve pivot.
  d. The long modification of the jet.
  e. The arm of the safety valve.

time, between vertical supports, Fig. 4 A. A better performance will be obtained by making a longer jet (*d*) of copper tubing flattened at its upper end and filed at an angle so that it just clears the rotor when the latter is moving, and delivers a flat jet of steam right under each successive blade. The model can also incorporate a safety valve which may also serve as a filler hole. At the point *b* in Fig. 4 B, a short length of $\frac{3}{8}$ in. round brass rod is sweated into place and drilled with a $\frac{3}{16}$ in. or $\frac{1}{8}$ in. hole, over which a ball-bearing may be placed. The ball is held down by a V-shaped strip of tinplate (*e*) flattened and slotted at one end so that it may be fixed by a short pin passing through one of the supports at *c*. The lid may be soldered into position now that a means has been provided for filling the boiler.

The time factor.—One possibility of getting the time necessary for attention to accuracy of workmanship and neatness of finish is to extend the science time allotment, by taking in part of the period usually given to handwork or other practical activity carried on in the school, as distinct from woodwork and metalwork done in craft centres. Thus the handwork of one or more classes can be put under the control of the science master.

If this is impossible, the boys can be encouraged to do the work in their spare time. The science room then becomes a depôt from which advice and raw materials may be drawn, and to which various oddments of materials and mechanisms may be brought for common use.

The time factor seems to operate, not so much in the number of working hours, as in the number of days or weeks over which they are spread. A boy is prone to lose interest in a model which takes a term to make, ignoring the fact that the total working time has been only a few hours, and to consider it to be a long job.

It is advisable, therefore, to organise the work so that it may be completed within as short a span of time as is reasonably possible. In addition, there is the likelihood that the science lessons will progress so far that before the model is finished the need which prompted its undertaking no longer exists.

More difficult apparatus.—We do not consider that these points operate against the making of more elaborate models. For some pupils, the satisfaction derived from progress in a really well-made model will provide the incentive for sustained effort. In such cases, if there is no reason why the model should be made quickly, one person could undertake the whole job.

Group work.—Where, however, it is desirable that a more advanced model should be made in a short time, its construction may be undertaken by a small group, each member being responsible for one or more parts of the model. It is essential, of course, that each boy should know what contribution he is making to the whole, and that he should realise that the success of the work depends on the care with which each part is made. The problem should, therefore, be discussed with the group beforehand. Supervision of the work is lightened if one member,—not always the same one,—be appointed to take charge of the work, and to act as an intermediary between the group and the master. This can usually be done when it is realised that another boy will be taking charge of the next model. There is scope here for some measure of social education. Added interest is provided, too, if the group is allowed to demonstrate and explain its model either to the class or at an exhibition of work.

With intelligent pupils, quite a high standard may be reached by an organisation of this kind. It is probably advisable, however, to alternate individual and group work.

Classroom equipment.—Where the science master is interested in model making, the laboratory fittings would include a bench for metalwork and woodwork, and a kit of tools, for his private use and so that the boys may have access to the equipment necessary for those processes of construction with which they find difficulty at home.

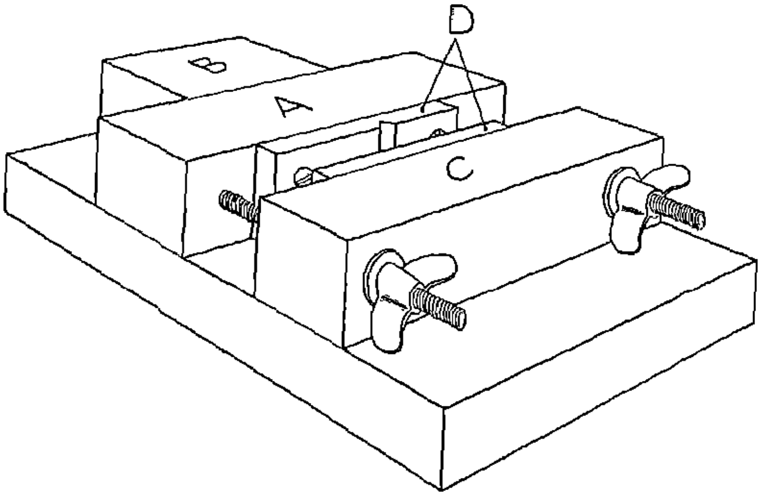

FIG. 5. A SUGGESTION FOR A MACHINE-VICE

A. Screwed from below, and drilled with $\frac{3}{8}$ in. holes for the bolts; backed with another piece of wood (B) to increase the rigidity.
C. This is free to move: drilled with $\frac{3}{8}$ in. holes.
D. Mild steel jaws, countersunk and screwed. One jaw is slotted with a file to assist in gripping round sections and in keeping them upright. The $\frac{3}{8}$ in. Whitworth carriage bolts, with squared shank to prevent rotation, are fitted with washers and wingnuts.

While much of the work of science handicraft is possible with a few very simple tools, a good deal of time and heartache may often be saved by the use of the correct ones, which are not to be found in every household. Many models, begun by a boy with great enthusiasm, are thrown aside unfinished on account of an apparently insuperable difficulty, which is instantly resolved when the boy is given access to a vice, a soldering bit, or a hacksaw. Some of the tools and minor equipment might even be made by the boys themselves for general use. It should be possible, in addition, to build up a small stock of hand tools, which can be loaned to individuals for a few days. This may avoid the educational evils of the "unfinished job," and the feeling of frustration which inevitably leads to loss of interest.

Craft guilds.—The interest can be sustained, and considerably extended, by the formation of a club or guild to meet occasionally in the science room for work and discussion, with the further incentive of an exhibition or an "open day" once or twice a year. By providing further opportunity as well as by the stimulation of interest, such guilds will speed up the work and minimise the disadvantages of a prolonged time span with more advanced models. In those schools whose only craft activity is woodwork, some scheme of this kind should be encouraged to give the boys at least a little experience of the simpler operations involved in the working of metal.

Co-operation with the craft teacher.—In schools having a separate craft centre in which woodwork or metalwork is being done under an instructor who is interested in model making, most of the science handicraft may be carried out in the craft periods. Science models or items of apparatus, graded according to their difficulty and the nature of the workshop processes they demand, may be introduced into a craft scheme without appreciable interference with its continuity. If they are products of close collaboration between the science and craft teachers they can be simple in construction, efficient in operation, and pertinent to the science work of the classes which make them. The inclusion of a few items as part of a rigid handicraft syllabus can hardly be recommended, for thus they may become stereotyped exercises divorced from the science work which should suggest their construction. Each model, as far as possible, should incorporate something of the boy who makes it, and should be the outcome of consultation between the boy and the teachers concerned. A few boys will be found who can carry through a project of this kind with very little guidance but the majority, particularly when beginning science handicraft, need a good deal of advice. The help given, however, should always leave room for the full exercise of a boy's initiative. In the provision of practical problems lies one of the chief merits of science handicraft.

In order that such a collaboration between the science and craftwork may be successful it is important, of course, that the craft teacher should know enough science to appreciate the principles which the model is intended to illustrate or to incorporate, and that he should realise the need for such simplicity of construction as is compatible with good workmanship. So often one finds a simple piece of apparatus so elaborated as to become an engineering job; in taking up a disproportionate amount of time, such work may easily kill the interest of the constructor, and its complication may completely overshadow the scientific purpose for which it was intended.

No less important is it that the science master should know exactly what he wants. In order that his contribution may be of value he should be something of a craftsman too. He should know the scope and limitations of materials and should be able to evolve a design capable of translation into a model which works. Then the real function of the craft teacher is to modify that design to give greater mechanical efficiency and finish, but without over elaboration.

The use of models.—One valid criticism of science handicraft as a class activity is that the handicraft tends to dominate the science. We may either accept the tendency frankly, and merely aim at teaching the elements of craftwork through the medium of science apparatus made during the craft periods, or explore every possibility of maintaining the balance by the widest possible use of the models made. In those schools where no other provision is made for metalwork the former attitude may easily be justified, and it would probably be the one adopted when the work is being done in the craft centre.

It is freely admitted that a boy who has taken ten working hours to make a model is not likely to employ the same number of science hours experimenting with it to any good purpose. On the other hand, by a free exchange of apparatus it should be possible for the model to be usefully employed for that length of time among the members of a class. Thus one should obtain a fair balance between the construction time and the period during which the model is serving as a medium of instruction to somebody. The products of science handicraft should be useful additions to the science apparatus and not merely "museum pieces." Many of them will find their place in the demonstration equipment, particularly those which, through the medium of interchangeable parts, may serve to illustrate several principles, or the successive development of one.

Examples of such models are to be found in Figs. 6 and 7.

The mechanics frame (Fig. 6), made on a stout base with 2 in. by 1 in. batten and backed by a full imperial size drawing board, may be used with the various fittings to cover much of the demonstration included in a first course of mechanics, even beyond the needs of a senior school. It would not, of course, replace large scale pulleys, levers and mechanisms such as bicycle parts, but would rather supplement them. Clips (*a*) hold the drawing board in position.

The following principles may be illustrated:

1. *Force, extension of springs.*—Hang the bar, which has a half-metre scale screwed to one side of it, by its hook (*c*) to the

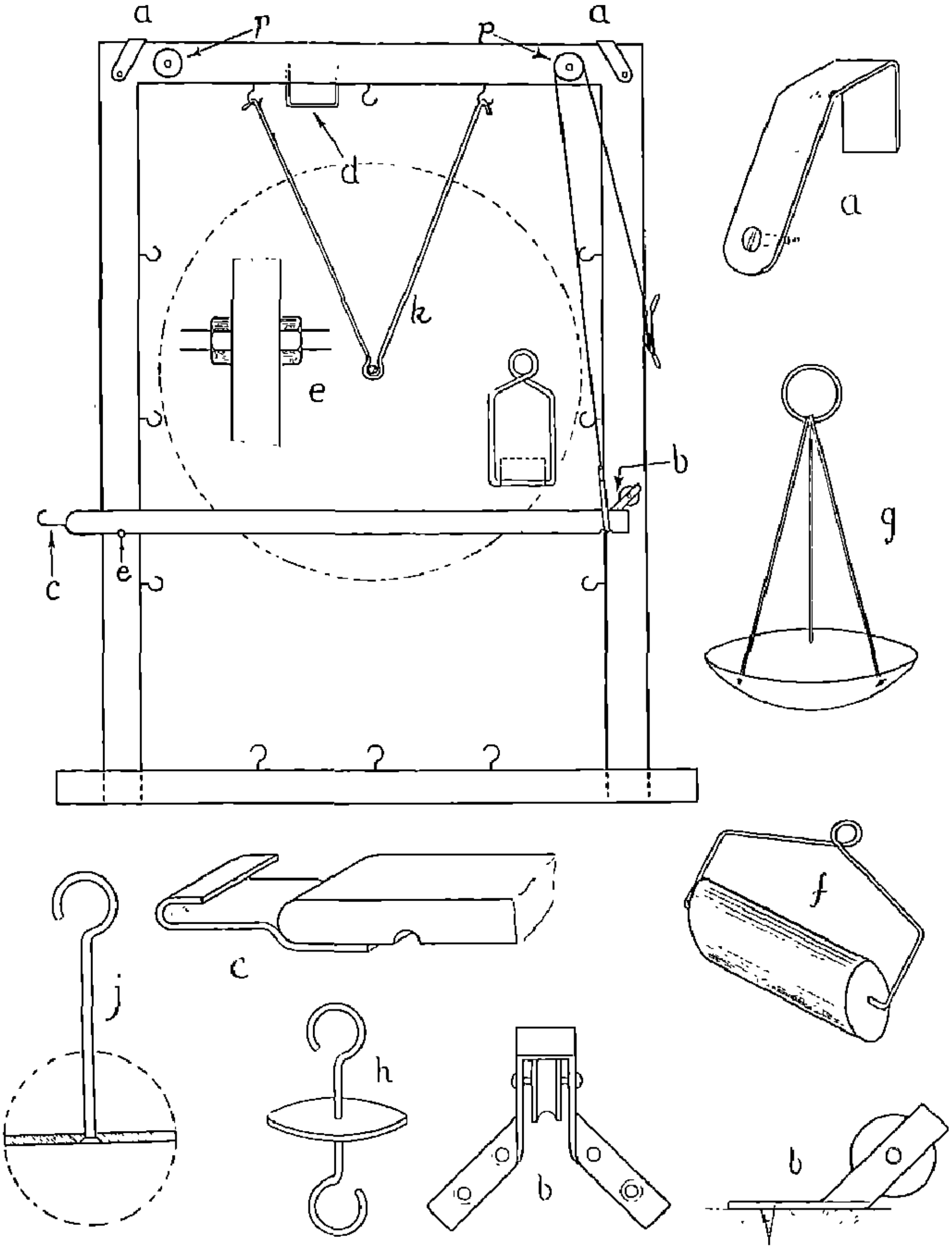

Fig. 6. The Mechanics Frame

a. Clips.
b. Small pulley.
c. Hook.
d. Staple
e. Pin.
f. Roller.
g. Scale pan.
h. Indicator.
j. Load pillar.
k. Suspensions.
p. Pulleys.

staple (*d*). To the nearest hook in the top of the frame fix a spring, with the indicator (*h*) and either a load pillar (*j*) or a scale pan (*g*) attached to its lower end.

2. *Parallelogram and triangle of forces.*—Three strings, knotted at a point, lead each to a spring balance. Other strings continue the spring balances to the hooks on the frame in variable states of tension. The central three strings are projected to a sheet of paper on the drawing board. The pulleys (*p*), (*p*), might be used with weighted strings for a similar purpose.

3. *Pulley systems.*—If the hooks are separated by distances equal to the radius of the pulleys used, simple systems may easily be set up inside the frame, with the drawing board removed.

4. *Friction.*—With the crossbar in the position illustrated, the string from a slide may be passed over the small pulley (*b*), at the end on the right, to lead to a load pillar or scale pan.

5. *Inclined plane and resolution of forces.*—A stirrup with a string over one of the pulleys (*p*) allows the crossbar to be pivoted about the pin (*e*). A roller (*f*) is made by drilling at the centre of each circular face of a thick brass rod to a depth of about ¼ in., and springing a bent brass wire into the holes.

6. *Moments.*—Galvanised iron wire is bent to make suspensions (*k*) for each side of a disc of 8 mm. plywood with a steel axle. From the centre is hung a plumb line, and weights are suspended from pegs fitting into holes drilled in the plywood, at random, but without upsetting its balance. By turning the crossbar over, the half-metre scale is brought into view and the bar is adjusted so that the plumb line crosses the scale at the 25 cm. mark. Moments may then be easily and rapidly computed.

Other uses will probably suggest themselves.

Fig. 7 shows a set of interchangeable parts from which one may rapidly assemble a series of electric motors.

In the first assembly (Fig. 7 A) the keeper bar, or armature, rotates across the poles of a horseshoe magnet which may be wound with about eight layers of 26 g. D.C.C. copper wire, either directly as on the near arm, or by the use of a bobbin (Fig. 7 B) shown in place on the other arm. Whichever method is employed, one must be sure that the direction of winding is reversed as the wire passes from one arm to the other, as in Fig. 7 A, in order to produce opposite poles at the two ends. The contact cam is fixed to the spindle in such a position that it makes contact with the brush about 30° before the armature arrives at the horizontal position, and breaks immediately the horizontal position is reached. Connect one terminal by a wire which is recessed into the underside of the baseboard, to one end of the field coil, the other end of which leads to one of the brushes. The other brush—the one which comes into operation with the wound armature—is connected to the second terminal, the latter being also joined to the pillar which supports the spindle, since in the arrangement shown at A the pillar, not the second brush, forms part of the circuit. In Fig. 7 C an armature similar to the first is wound with six layers of 26 g. D.C.C. copper wire, starting in the middle and proceeding continuously up and down to finish in the middle. Coat the wire with shellac varnish after every two layers. Avoid taking the coils too far along the bar; sufficient bare iron must be left to allow its free passage within $\frac{1}{16}$ in. of the pole faces of the field magnet. As a precaution against shorting the coils with the edge of the iron bar, and as a reminder not to carry the first layer too far, it is advisable to stick a strip of gummed linen tape round the iron where the coil is to be placed.

To make the commutator, drive a peg of whitewood into a ⅝ in. diameter brass tube, cut to ⅝ in. in length and trim the ends with a file. Drill centrally to take the spindle as a tight fit and then cut the slots with a hacksaw. Slide each segment nearly off the core, smear it and the wood with liquid glue, and slide it back into position. When

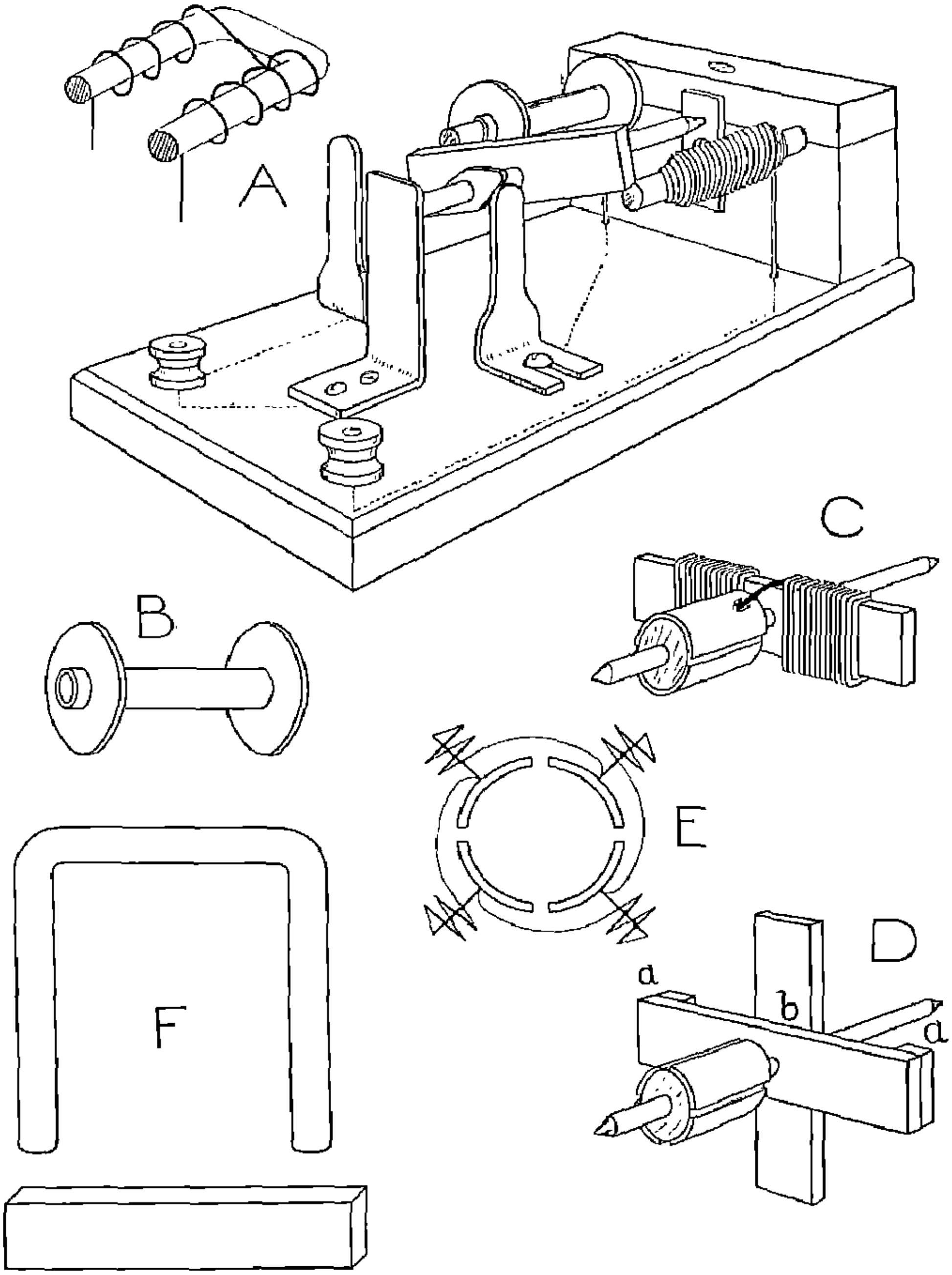

Fig. 7. Components for the Assembly of a Series of Electric Motors

A. How the coils are wound. B. Bobbin. C. Wound armature.
D. Four-pole armature; (*a*) and (*b*) joints.
E. Wiring. F. Field core and armature.

the glue has set, mount the commutator, clean it up with emery and solder a wire to each segment. Its position may be adjusted by turning it a little on the spindle.

When making the four-pole armature (Fig. 7 D) the joints *a* and *b* may be soldered, the small pole pieces serving to bring the four poles into the same plane of rotation. As an alternative, the joint at *b* may be halved and lapped (see *Woodwork Joints*), thus avoiding the need for pole pieces at *a*, *a*. Wind the coil in the same direction on each of the four arms, connecting the input of one and the output of the next in order, to one of the segments, Fig. 7 E. It would not be out of place, here, to suggest a method—not necessarily the best—by which this set might be used in teaching. Suppose we are just familiar with the attraction of a soft iron keeper by a permanent magnet. The keeper is hung in a cradle on a thread and is found to swing through part of a circle when released in a field produced by two permanent magnets arranged as are the magnets in Fig. 8, but coming to rest along the magnetic axis.

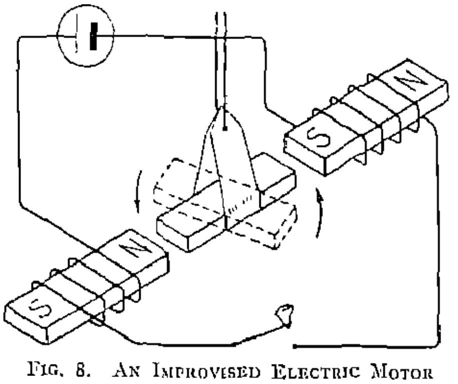

FIG. 8. AN IMPROVISED ELECTRIC MOTOR

Replace the permanent magnets by bars of iron with a few turns of wire round each, the turns being taken in the same direction, when by making and breaking the circuit at the correct times a continued rotation is produced. Our first motor does this automatically. Now we can use not only the attraction effect, but also that of repulsion by magnetising the armature and changing its polarity as it swings into line, by means of the split tube commutator. The first armature is therefore removed and replaced by the two-pole wound armature, the second brush being swung into position and both brushes adjusted. Further improvement is obtained by introducing four impulses per cycle instead of two, by putting in the four-pole armature. Other improvements, such as the three-pole armature for self starting, enclosed fields, built up cores, etc., are introduced in later models, but this series should show the possibilities of interchangeability.

BASIC PROCESSES

The following account of some general working processes brings forward the main points to observe in carrying them out. It does not set out, however, to replace the course of woodwork and metalwork under the direction of an instructor, which would be valuable to all who are taking up science handicraft seriously.

Marking out.—This should always be done carefully, for it forms the foundation of all subsequent operations, to a large degree setting the standard of the work to follow. It should be carried out with the aid of steel rule, trysquare, and dividers, for eye-judgements may easily lead to error. For those who wish to get a fair efficiency from their models these small errors are important. This will be evident in electromagnetic models when it is considered that magnetic fields, being subject to the inverse square law, decrease in strength rapidly as the distance from the pole increases. The variation in performance among models constructed from the same design is clear evidence of the need for care in construction. Much of the inefficiency of the poor performers can be traced to careless marking out.

Wood.—Mark off with pencil lines a part of the board a little larger in both dimensions than the article; e.g., a baseboard, being made, and cut along the lines with a handsaw. Generally the marking should be done so that the grain of the timber runs with the longer dimension. Next plane the surface, testing with the edge of a steel rule or trysquare blade to see that it is quite level. This, the "face side" should be characteristically marked in pencil for later identification. Then, holding the wood in a vice, plane a long edge. Test it with a square to see that it is at a right angle to the face side, and mark it for identification as the "face edge." All further measurements should now be made from these two surfaces as planes of reference. The final marking is best done with a marking knife as far as possible, since a cut line is more precise and permanent than one made with a pencil. Widths and thicknesses are marked from the face side or face edge with a marking gauge.

Metal.—One usually uses a pointed steel rod or scriber except when working with tinplate when pencil lines are preferred. This is to avoid unnecessary damage to the protective coating of tin, for scratches soon lead to corrosion. Suitable scribers may be made by grinding to a point a length of "silver steel" rod, which is then hardened and lightly reground (see *Heat Treatment of Metals*).

As before, a piece of metal of sufficient size is marked off on the sheet and cut,—this time with shears (snips). If the metal is distorted as a result of cutting from the sheet, flatten it by tapping on a smooth anvil with a wooden mallet before beginning to mark out. The design may then be scratched with the scriber, or pencilled, ready for cutting out. Two lines exactly at right angles, either edges or axes of reference, are first scribed on the piece of metal, and from these all further measurements should be made. It is often possible to file up a straight edge from which the construction is developed by the full use of the trysquare and steel rule. Dividers are used for striking arcs and circles. Centres should be marked by crossed lines for drilling at a later stage.

Cutting.—*Wood.*—Where the design permits, it is advisable to saw nearly up to the marked line on the waste side, to allow the material to be planed exactly to the line. When cutting across the grain, at the end of a baseboard for instance, one should aim at sawing carefully right up to (but

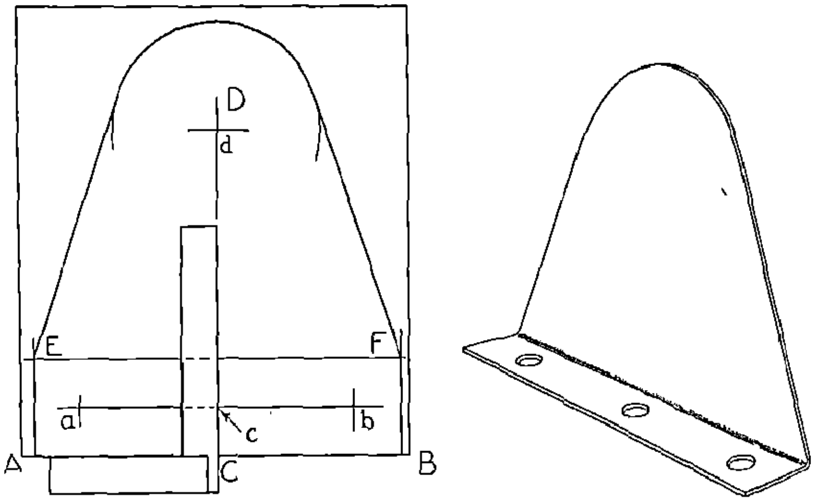

Fig. 9. Marking Out of Metal

AB is the straight edge, and CD the vertical axis of reference. Centres are marked at *a*, *b* and *c* for drilling holes, and at *d* for striking the top curve. EF marks the line along which the fold is to be made. The finished bracket is shown on the right.

not on) the line, since planing across the grain is likely to split the corners unless carefully executed with certain safeguards. The cutting of a joint also should be done right up to the line, always on the waste side, so that it may be assembled with the minimum of chiselling to fit (see *Woodwork Joints*).

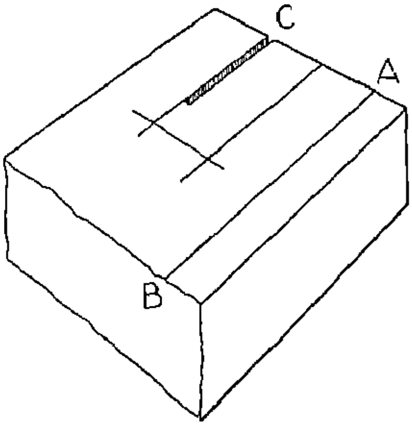

FIG. 10. CUTTING OF WOOD

The diagram shows the allowance left on the waste side of the marked line AB; $\frac{1}{16}$ in. is generally enough. At C is shown an incomplete sawcut right up to the line, as in cutting a joint.

Metal.—The cutting of metal sheet is usually done with shears held in the hand, but if the metal should be rather difficult to cut that way try gripping one arm of the handle in a vice, pushing down on the other to achieve the cut.

One point about shears is worth bearing in mind. When buying them, be sure to order the "no nip" type in which the ends of the handles do not come together at the close of the cut. This will save the hand from many a painful nip which the other type is likely to give with incorrect handling. As with wood, it is generally advisable to cut on the waste side of the line to allow for finishing, in this case by means of a file. Heavier gauge sheet metal, rods, bars and tubes, being outside the scope of hand shears, demand the use of a hacksaw which should be operated with long, steady strokes, while the material is held firmly in a vice. Some boys, in search of speed, show a tendency towards short rapid strokes, but the error can be easily recognised. This applies also to filing.

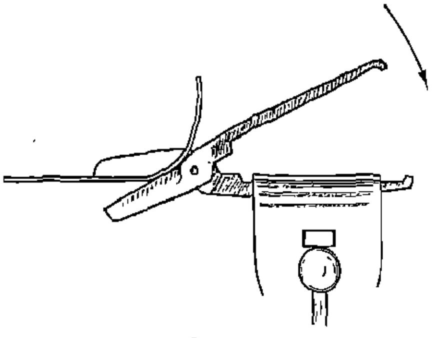

FIG. 11. SHEARS MOUNTED IN A VICE FOR CUTTING METAL

Should a boy have occasion to replace a worn or broken blade, make certain that he puts in the new blade with the teeth pointing forward,—judged by running the finger along the cutting edge,—as the hacksaw cuts on the thrust. Never lubricate the work while sawing. If the blade should become too hot to touch comfortably, withdraw the saw for a few moments to allow it to cool down.

There often arises a situation in which shears and hacksaw alone will not suffice. The following methods will then be found useful.

Suppose we want to cut a vee slot in a sheet of metal, Fig. 12 A. The figure is marked out and a hole of about $\frac{3}{16}$ in. diameter is drilled in the point of the angle. Then, with shears, we cut from the edges at *a*, *a*, to the hole, leaving about $\frac{1}{16}$ in. for finishing with a file. In this case the vee piece falls away, but when removing a rectangular piece (Fig. 12 B) a further operation is needed. To remove the metal after cutting along the two sides we must also cut along the line from *b* to *c*. Two methods are available. One is to cut the metal with a piercing saw (a small fretsaw for metalwork). This is rather a tricky operation, particularly with thin material, as the metal is liable to catch between the teeth of the blade and snap it. To avoid this, one should saw at an angle of about 45° to

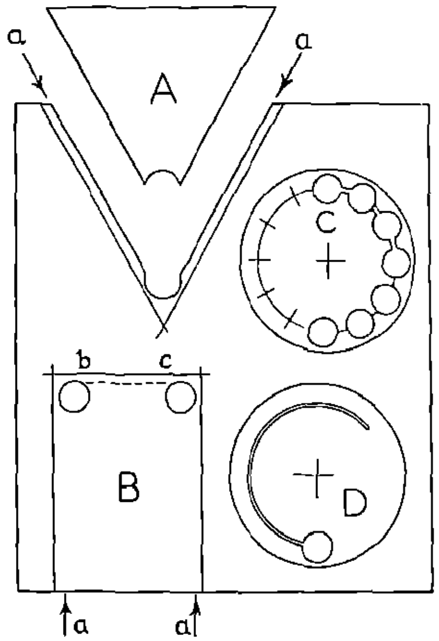

FIG. 12. CUTTING OF METAL

- A. Vee slot in a sheet of metal, *a*. Edges to be cut.
- B. Rectangular piece to be removed. The line from *b* to *c* is to be cut.
- C. *Proceeding anti-clockwise from the top of the* circle, the centres are marked, the holes drilled and finally the bridges cut with a chisel.
- D. A similar circle partly cut out with a piercing saw.

the metal as shown in Fig. 13. When putting in a new blade, remember that the saw should cut on the down stroke and therefore the teeth point towards the handle. Compare this with the hacksaw above.

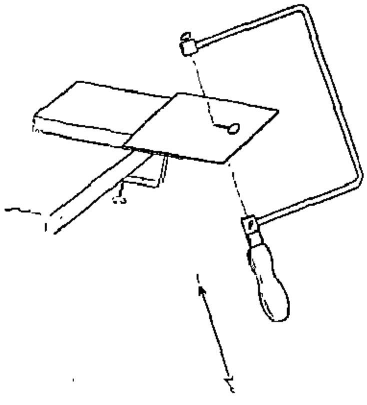

FIG. 13. THE USE OF A PIERCING SAW WITH THIN METAL SHEET

The other method is to drill a line of holes (Fig. 12 C) within the waste metal and separated from each other by a short distance. The bridges are then cut by means of a cold chisel. When the main mass of metal has been removed, by one method or other, finish to the line with a flat or a half-round file. The circle might, of course, be cut out with a piercing saw as in Fig. 12 D. In the interest of economy, boys should be encouraged to use small pieces of metal from the scrap-box if they can, rather than to cut into a large sheet.

Planing.—For most ordinary purposes the jackplane should be sufficient. There are occasions when the smoothing and trying planes are required, but these are more normal items in the equipment of a woodwork shop and the reader is advised to consult a woodwork instructor with regard to their use.

Working on the face of the wood.—The plane should be held with the left hand across its nose, palm over the button, with the fingers pointing down over the right-hand side of the plane. This gives a close control over the pressure applied during the stroke. At the beginning of the stroke the pressure should be mainly on the nose of the plane with the left hand, diminishing as the stroke proceeds with a corresponding increase in that applied to the handle with the right hand. Most of the downward pressure at the end of the stroke should be at the handle. In this way one avoids the domed surface produced by beginners when they cut up at the beginning and down at the end of the stroke.

The surface should be tested for level in all directions by using a reliable straightedge. When there is a slight twist in the wood it is advisable to plane from corner to corner instead of parallel with the grain. If the wood shows signs of tearing, leaving a rough surface, the cut is probably being made against a grain which is sloping downwards in the direction of the stroke, thus allowing the cutting iron to get underneath the fibres of the timber and lift them, Fig. 14 A. Try turning the wood end to end, when the cutting edge will meet a rising grain and will probably produce a smooth cut, Fig. 14 B. In most cases, an examination of the grain at the edge will suggest the better direction for a smooth finish.

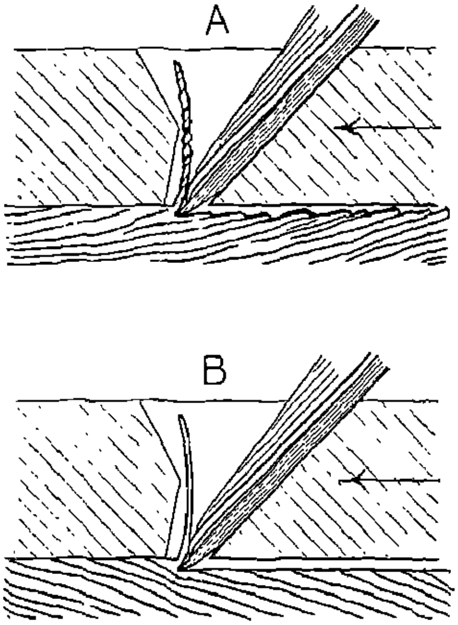

Fig. 14.

A. The plane iron cutting against the grain gives a rough surface.
B. A smooth surface cut with the grain.

To plane an edge.—Fix the wood firmly in a vice and hold the plane so that the thumb of the left hand is just behind the button, the fingers passing just underneath the sole of the plane to touch the vertical face of the wood. This grip makes it easier to guide and to steady the plane along even a narrow edge. As with face planing, press more on the nose of the plane at the beginning, and on the handle at the end of the stroke. Test the edge for straightness as before and be sure that it makes a right angle with the face side. A bevel, or a chamfer, given to an edge often improves its appearance and wearing qualities. Mark the depth of the chamfer on both side and edge, and plane down to the lines as if planing an edge, but with the plane sloped at the required angle, usually 45°. The end chamfers across the grain had best be cut with a chisel unless one knows how to avoid splitting the corners when planing across the grain.

The use of the chisel.—The various uses of the chisel can only be acquired by practice under the direction of a craftsman, and we can do no more here than to suggest a few safeguards. It is as well to think for a moment of what the tool might do if it slips,—that will often suggest a safe method of holding it. A chisel should always be held firmly, the drive being applied with the right hand while the left is employed in guiding the blade and in moderating its movement if it should slip. If the cut is always made either downwards on to a board or a bench hook, or away from the body, few accidents should occur. Keep both hands behind the cutting edge. One should aim at removing thin slices of the wood rather than thick, as one can then produce a better finish while keeping closer control over the tool.

Filing.

A flat surface.—Fix the work firmly in a vice with the working edge or face close to the vice jaws, about $\frac{1}{4}$ in. or $\frac{1}{8}$ in. of the metal protruding. Good results are impossible unless the work is well supported. The file strokes should be firm and unhurried, about one per second, and the file should be made to travel in a horizontal plane from the

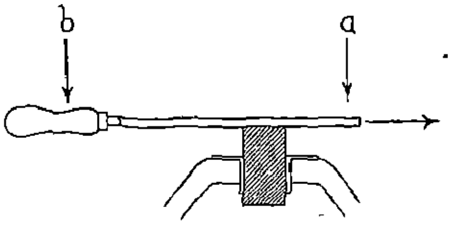

Fig. 15. Filing a Flat Surface

a. Nose of a file.
b. Handle.

beginning to the end of the stroke. This is simplified by putting a pressure with the thumb (for light work) or the heel (for heavy work) of the left hand on the nose of the file (Fig. 15*a*) at the beginning of the stroke, and finishing with the pressure on the handle, Fig. 15*b*. The idea is to keep the "moment" of the forces equal about the region of contact between the file and the metal.

If the wrist, elbow, and shoulder are kept in the same vertical plane, the file can be kept under close control even for heavy work. Success in filing a flat surface depends on keeping the file constantly in a horizontal plane, neither tilting to the left or right, nor allowing the nose to rise or fall. The initial tendency to file a domed surface may be overcome with a little practice. Wherever possible, fix the work in the vice in such a way that the working surface will be finished in a horizontal plane. It is easier to maintain the strokes horizontal than, say, at an angle of 20° to the right. Tilt the work rather than the file, as a general rule.

Edge filing.—When filing the edge of sheet metal, stand to one side of the vice and place the file across the edge of the metal at an angle of about 30°, as in Fig. 16. The stroke, is made both along and across the edge simultaneously, in the direction shown by the arrow.

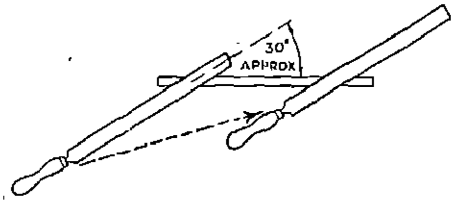

FIG. 16. FILING AN EDGE—SHOWN IN PLAN

In this way the waste metal is removed almost to the scribed line, and the edge is ready to be smoothed off. This is done by placing the file firmly along the edge (Fig. 17), keeping a steady pressure with the thumb of the left hand at a point (*a*) above the work, and driving the file through a distance less than the length of the edge so that the pressure of the thumb, which moves with the file, does not pass beyond the limit of the work from (*a*) to (*b*). Lift the file clear at the end of the stroke; do not slide it back along the edge. A few strokes should be sufficient.

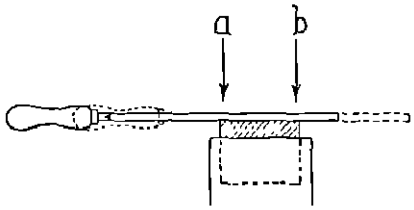

FIG. 17. FINISHING A STRAIGHT EDGE
a–b. Section covered by pressure of thumb.

Edges of bars may be bevelled by fixing the metal at an angle of 45° in a vice and filing with a horizontal movement as before, Fig. 18.

Draw filing.—A good finish may be obtained by placing a fine file across the metal at right angles to its length, gripping it on both sides of the work, and moving it backwards and forwards along the entire length several times. This does not remove much metal, but smoothes out any previous file marks. The method is useful for finishing brass contact strips and brushes, and other small articles which may be held in the clamp shown in Fig. 19. A piece of hardwood, about 6 in. by 3 in. by 1 in., forms the platform. A second piece about 1in. square section is drilled and countersunk for three stout screws by which it is fixed to the lower face of the platform. At one end of the upper face is fixed a strip of iron or steel, 2¾ in. by ⅝ in. by ⅛ in. approximately drilled and countersunk for the two wood-screws which hold it. With the lower part

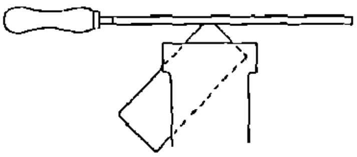

FIG. 18. FILING A BEVEL

fixed in a vice, this clamp forms a useful addition to the equipment.

The safe edge.—Some flat files are made with cuts on three surfaces, only one edge, —the safe edge,—being left smooth, Fig. 20. This allows the jaws of the vice to be used as guides in filing a tenon, or in reducing the diameter of a rod, as the file cuts inwards and not downwards.

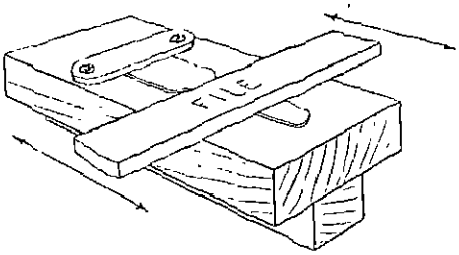

FIG. 19. A CLAMP FOR DRAWFILING

Files.—The most useful files for general work are 6 in., second cut, half-round and flat, the latter with a safe edge. It is worth while having one or two 9 in. flat ones, also with a safe edge, and of a coarser cut, for heavier work. A box of half a dozen assorted warding files and a few rat-tail ones are also required. One sometimes sees files being used without handles,—a rather dangerous procedure, and one which is not justified by a consideration of cost. All files should have handles of some kind, even if they serve only to prevent the tang of the file from penetrating the hand should a false stroke or a slip occur.

Soft metal tends to clog the files, but most of it may be removed by rubbing along the cuts with a wire file cleaner after use. This treatment, however, is not very effective with soft solder. As a rule, waste solder is removed from a joint with a scraper, which can be made by grinding a knife edge on an old triangular file. Only very old files should be used for cleaning up the soldering bit, and these should be kept for this purpose only.

Soldering.—The strength of a joint between two pieces of metal by this method depends on the degree to which they form an alloy with the solder at their surfaces, giving a perfect continuity of metal from one piece to the other. It is therefore imperative that the surfaces to be soldered should be quite clean. They should be freed from grease, say with petrol or some similar solvent, and then either scraped or rubbed with clean emery cloth. With such precautions one may be certain of starting with clean bright surfaces, but under the influence of heat,

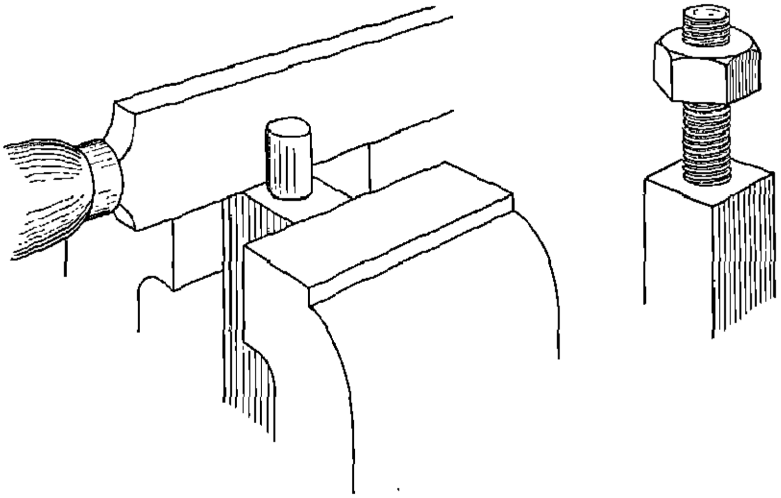

FIG. 20. FILING A TENON, USING THE SAFE EDGE OF THE FILE

oxidation may occur later. The oxide film, thin though it is, suffices to prevent the local alloying. It is to counteract or to prevent such oxidation that fluxes are used.

Fluxes.—The following are among the most common:—

ZINC CHLORIDE (killed spirit) is made by dissolving scrap zinc in a mixture of equal parts of concentrated hydrochloric acid and water. The reaction should be carried out to completion in the open or in a fume cupboard, excess of zinc being present. Decant and bottle for future use. This is an excellent general purpose flux for soldering copper, brass, iron and steel. If used for making joints in an electrical circuit, however, the excess must be thoroughly washed away afterwards, otherwise electrolytic corrosion will rapidly occur.

FLUXITE is useful in that it has much less tendency to provoke corrosion.

ROSIN, from an electrical point of view, is excellent. Its action is uncertain with metals which have not been thoroughly cleaned other than copper, but its use entirely prevents corrosion.

BORAX, is a high temperature flux, unsuitable for use with soft solder. It is used in brazing and hard soldering. Its chief use in science handicraft is in the making of silver solder contact points, to which reference is made later.

DILUTE HYDROCHLORIC ACID (10%) is an adequate flux for use with zinc.

The soldering bit.—This should be heated at the heel, not near to the point, since the main mass of copper is to serve as a reservoir of heat to supply the working point by conduction. Overheating, when the flame becomes green and blue, should be avoided, since at a high temperature the copper turns to bronze by alloying with the tin in the solder, becoming very hard and leaving too great a proportion of lead in the "solder" at the working point. When hot, dip the point into the flux for a moment and take up a small bead of solder for working. If the point should be badly burned or pitted it should first be cleaned and levelled with a very old file kept for that purpose, then tinned.

Tinning.—Before using a new or reconditioned copper bit its point should be given a light coating of solder to enable it to pick up more solder when in use. To do this, heat the bit as if it is about to be used normally, dip it in flux and rub it well on a small bead of solder lying on a sheet of slate, asbestos board or other heat-resisting material. If dipped occasionally into the flux during the process the point soon acquires the necessary layer of solder, thus becoming ready for use.

Making the joint.—To make a simple lapped joint clean up the two surfaces which are to overlap, as described above, wet them well with flux and place them firmly in position as shown in Fig. 21, diagrams *a* and *b*. Take the hot bit with a little solder at the point and apply it to the lap keeping it steady until the solder begins to flow into the joint. Then move it slowly along the joint, leaving behind as little surplus solder as possible. After reheating if necessary, draw the point of the bit slowly from end to end of the joint in one movement to give an even and smooth finish. The excess solder should then be removed with a scraper, not with a file.

Sometimes the solder fails to flow right through the lap, leaving a certain weakness. This can be avoided if the two surfaces are tinned lightly before being joined. Prepare them as before and then, using the bit, coat the overlapping surfaces (the shaded portions in Fig. 21 *a*) with as thin a layer of solder as possible. If they are again fluxed and treated as in the previous paragraph, a perfect join should result.

Generally speaking, a lapped joint is a strong one since the areas of metal in contact are appreciable, and the stresses to which the solder is subjected are not likely to cause a fracture.

Butt joints, like those shown in Fig. 21, diagrams *c*, *d*, and *e*, are often useful in situations where little stress is likely to arise,

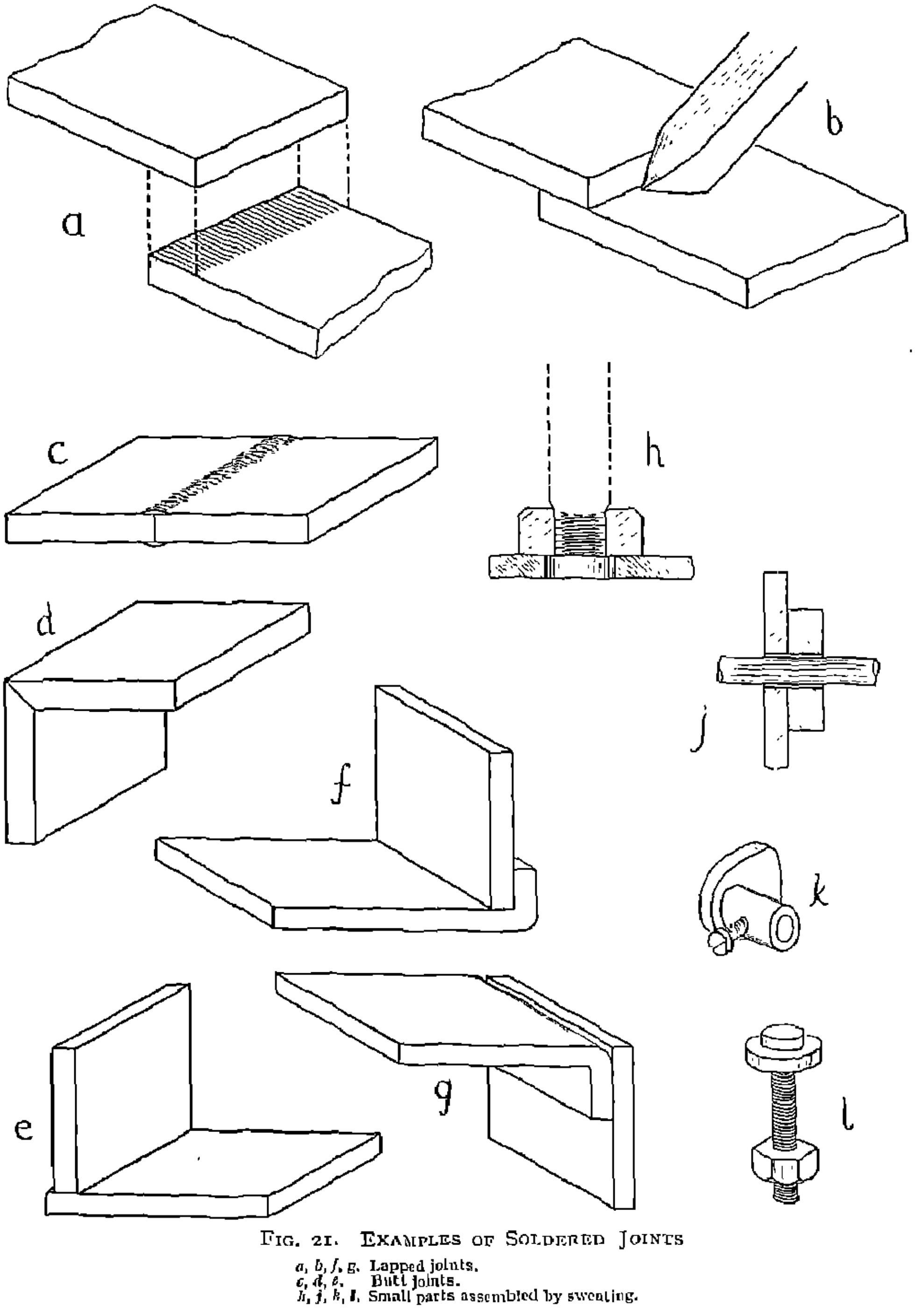

Fig. 21. Examples of Soldered Joints

a, b, f, g. Lapped joints.
c, d, e. Butt joints.
h, j, k, l. Small parts assembled by sweating.

and with care they may be given a very neat appearance. Extra strength may be obtained either by mitring the joint (Fig. 21 *d*) or by leaving a backing of solder around it, though the latter is likely to mar its appearance. By arranging the lap on the inside or the outside of the joint as the occasion suggests (Figs. 21 *f* and *g*) the neatness of a butt joint may often be obtained without its inherent weakness.

Sweated joints.—When dealing with small objects or such joints as are not easily reached with a soldering bit, the parts may be sweated together. First tin the surfaces as before, coat with flux, place them in position and press them together with an iron rod.

The heat, applied by means of a blowpipe (Fig. 22) or bunsen burner, is directed on the metal at a short distance from the actual joint, when the solder is fused by conducted rather than direct heating. This ensures that all the solder is melted, thus giving a good joint. Direct heating may cause fusion at only one or two points, leaving the joint weak, since the solder will not adhere to cold metal. This method is useful for attaching nuts to sheet metal (Fig. 21 *h*), for thickening a bearing to take a shaft (Fig. 21 *j*), for fixing a cam-plate to a short piece of rod prior to drilling it and fitting it with a setscrew (Fig. 21 *k*), and for sweating a disc of silver-solder into position to serve as an electrical contact (Fig. 21 *l*). Other applications will readily suggest themselves.

If there should be any other soldered joints nearby, there is the danger of their failure through conducted heat from the region being treated. To avoid this, pack them round well with wet cotton wool or waste. While this is kept wet and in close contact with a joint, there should be no fear of its being damaged. One further point; since the metal to be treated must be hot, it is often advisable when the work is being held in a vice, to place pieces of asbestos sheet between the work and the vice jaws to reduce loss of heat by conduction.

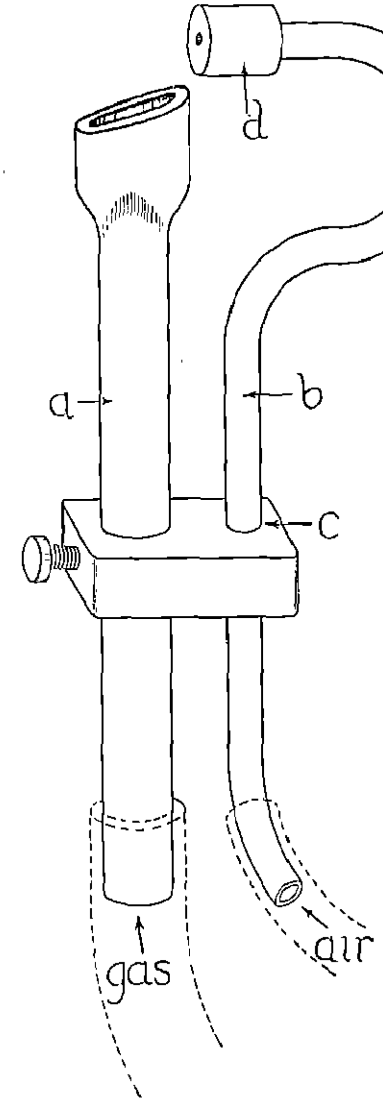

FIG. 22. A GAS BLOWPIPE

a, $\frac{3}{8}$ in. brass tube flattened at the tip.
b, $\frac{1}{4}$ in. copper tube soldered into the brass block at *c*.
d, $\frac{1}{2}$ in. brass bar, drilled with $\frac{1}{4}$ in. hole and soldered; $\frac{1}{16}$ in. hole drilled through from the front.

Silver solder.—This is useful as a substitute for platinum in making electrical contact points. If warmed and dipped in solid borax, silver solder wire can be fused gently to a bead in a bunsen flame. Dissolve away the borax with dilute sulphuric acid. When the bead is hammered out cold, the disc obtained forms a good contact plate which can be sweated into position by the use of soft solder. The surface may then be cleaned and levelled with an old file. If the wire is fairly stout, say 22 g., a serviceable point may be made by sweating the wire into a hole about $\frac{1}{8}$ in. deep in the end of a rod or screw, cutting off to leave about $\frac{1}{16}$ in. exposed and filing it square (see Fig. 1 C).

Rebushing a bearing.—Should the bearing of a motor become worn it need not always be replaced. Clean up and flux the inside of the bearing and run in some soft solder to give a thin, continuous lining. The surplus can be scraped away, and if done carefully the soft metal bush produced should provide a durable bearing surface with a low friction loss.

The bending of metal.

Sheet metal.—One of the simplest methods of obtaining a sharp angular bend is to use one of the vice jaws as a former. Mark with a scriber the line along which the bend is to be made and fix the metal firmly in the vice so that the edge of the jaw coincides with the line, Fig. 23 A.

Thin sheet may be pushed over at *c* with the thumb, needing only a final light hammering to complete the bend. Heavier gauge metal will probably need blows delivered at *c* with a mallet in order to bring it over. A hammer may be used so long as care is taken not to bruise the metal. For bends into shapes other than a simple right angle it is advisable to employ a "former" or "stake," whose shape corresponds fairly well with that of the finished article. Two examples are shown at *e*, in Fig. 23 B and C. When the work involves a considerable amount of metal bending it is worth while collecting suitable formers such as gas-barrel and thick iron bars of various sections, and to keep the designs to a few standard dimensions to suit the range of formers available.

Rods.—These may be bent by the same methods, but they do not form so easily a sharp angle. A former with a rounded edge

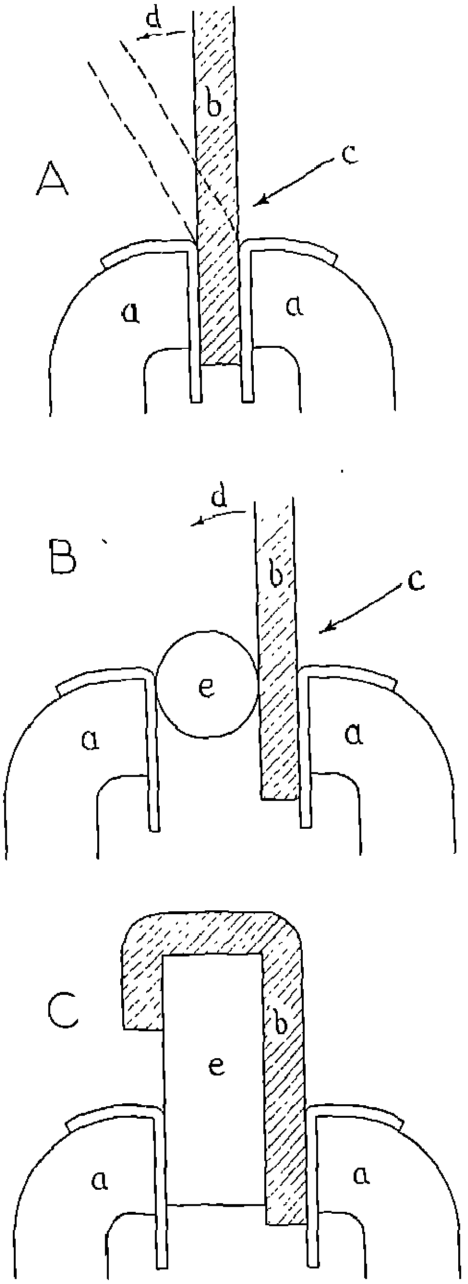

FIG. 23. BENDING OF METAL IN A VICE

A. Using the jaw as a stake. B and C. Using a former, *e*, *e*.

a. Vice jaws.
b. Metal to be bent.
c Hammer here if necessary.
d. *Direction of pull.*
e. Former.

is therefore preferred in order to extend the zone of distortion and thus limit the intensity of the strain produced. Otherwise a fracture is quite likely to occur, or at the best, the metal will be made hard and brittle at the bend. This condition of "work hardening" may usually be relieved by annealing (see p. 418). In order to prevent the whole rod from bending as it is pushed over the former, pull steadily in the direction of the arrow at *d* (Fig. 23 B) while hitting the metal at *c*, just a little above the region of its contact with the former.

Stretching of metal.

The making of a contact brush.—By hammering, a metal is caused to stretch, becoming thinned and work hardened at the same time. In certain cases, such as the making of electrical contact brushes, this may be an advantage since the brush is then springy and follows any slight irregularities in the commutator, Fig. 24.

Care should be taken to avoid over hardening and the consequent tendency to split under the hammer. A strip of 26 g. brass is cut, roughly to the shape of the required brush, and for about two-thirds of its length is hammered on a smooth iron anvil, the remainder being left untouched for the subsequent drilling and bending to provide a means of fixing it to the baseboard. Should it become distorted as in Fig. 24, further hammering in the shaded area, *a-b*, will correct the distortion. It may then be cut and filed to shape, a slot being made at *c* to permit adjustment when in use. The face of contact should then be smoothed first with a fine file and then with emery cloth. The clamp shown in Fig. 19 will be found useful for this operation. A very good contact is obtained if the upper part of the brush is wrapped with two layers of fine copper gauze, which may be held in place with a touch of solder on the side away from the commutator.

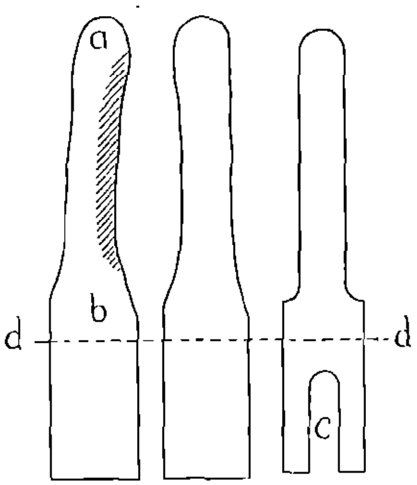

FIG. 24. MAKING A CONTACT BRUSH

Distortion on hammering is corrected by further blows at *a–b*. A slot is cut at *c* and the foot bent over along *d–d*.

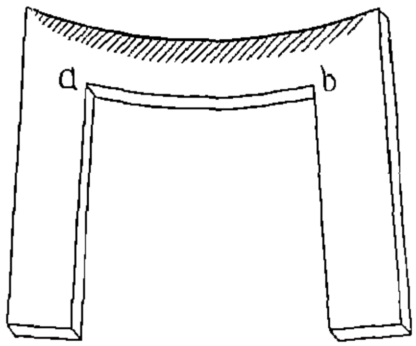

FIG. 25. STRETCHING METAL BY HAMMERING; HAMMER IN SHADED AREA

a–b. Line along which the chisel cut was made.

When sheet metal has been cut with a cold chisel it sometimes becomes distorted by being stretched along the line of the cut. Its shape can be restored by hammering a corresponding part, such as the shaded portion in Fig. 25. In this diagram, *a–b* represents the line along which the chisel cut was made.

Drilling.

Wood.—When boring or drilling in wood, one should use a centrebit or dowel bit, whose central point prevents the bit from drifting and following the grain. Thus, in clearing a recess to house the nuts in Fig. 26, the baseboard is drilled on the underside with an appropriate centrebit to give a large hole of the required depth. A smaller hole to accommodate the bolt shank may then be made with a clearing size twist drill, preferably from the upper face of the board, to meet the larger hole. In those cases where a twist drill must be used to drill through wood in the direction of the grain, as for example in the construction of a tube type commutator, it is advisable to choose a material like American whitewood, whose grain is not pronounced, otherwise the drill will probably follow the soft spring wood, being pushed aside by the harder layer of summer wood.

Metal.—First mark the centre with crossed lines and start the hole with a centrepunch. The punch should be tapped lightly the first time to make sure that the dent occurs exactly at the right place. Then follow up with a heavier blow. Fix the work firmly in a vice if it is thick, or in the case of thinner sheet metal lay it flat on a piece of wood, at the same time precluding any tendency for it to rotate by driving in some small nails on either side of it. Never hold it in position with the fingers, for the drill may suddenly bind and swing the metal round to inflict a nasty cut. Insecure mounting of the work is a fruitful cause of broken drills. The drill should be rotated steadily and fed into the work carefully. Should the feed be too rapid, or the pressure too great, the drill will bend, causing it to drift, and it will probably snap. A few drops of oil put on the drill when working with soft iron or steel will run down into the hole to provide the necessary lubrication.

If, at the beginning, the hole is not quite in the right place, it is often possible to bring it to the correct position by tilting the brace through about 30° from the vertical during several turns of the drill, bringing the point to the right place, and then gradually restoring it to its vertical position. A few trials should give a clear idea of the possibilities of this mode of adjustment.

A bench drill with a chuck to take up to $\frac{3}{8}$ in. is a very useful addition to the laboratory equipment. It is not a costly item. Not only does it save a great deal of time, but it ensures a higher standard of accuracy when used in conjunction with even a home-made machine vice. The only drawback to its general use is that an inexperienced person may feed the smaller sizes of drill too rapidly into the work, and break them. One should guard against this as the small drills are rather difficult to set satisfactorily after being damaged.

Drill sizes.

B.A.	0	2	4	6	8
Tapping	$\frac{13}{64}''$	$\frac{5}{32}''$	$\frac{1}{8}''$	$\frac{3}{32}''$	$\frac{1}{16}''$
Clearing	$\frac{1}{4}''$	$\frac{3}{16}''$	$\frac{5}{32}''$	$\frac{1}{8}''$	$\frac{3}{32}''$

When holes are to accommodate screws or bolts care must be exercised in the selection of the drill to be used. Clearing drills give a hole in which the bolt may move freely, while tapping drills form one which is small enough to allow the appropriate thread to be cut in its walls. Thus, referring to the table above, a 2 B.A. screw will just pass freely through a $\frac{3}{16}$ in. hole, but a $\frac{5}{32}$ in. drill would be needed for a hole in which a 2 B.A. thread is to be cut.

It will be found convenient to keep the drills in a drillplate. Mount a sheet of brass about 4 in. by 3 in. on a stout baseboard and drill a series of holes through the brass into the wood corresponding in plan to the table of drill sizes, given above. If each hole is drilled with the drill it is to accommodate and its B.A. size marked by its side, much time will be saved in the selection of appropriate drills. Two other holes might be provided, one for the centrepunch and the other for a countersink bit.

Cutting a thread.

Thread sizes.—In science work we seldom are in need of more than four sizes of thread: 0, 2, 4, and 6, British Association. Whit-

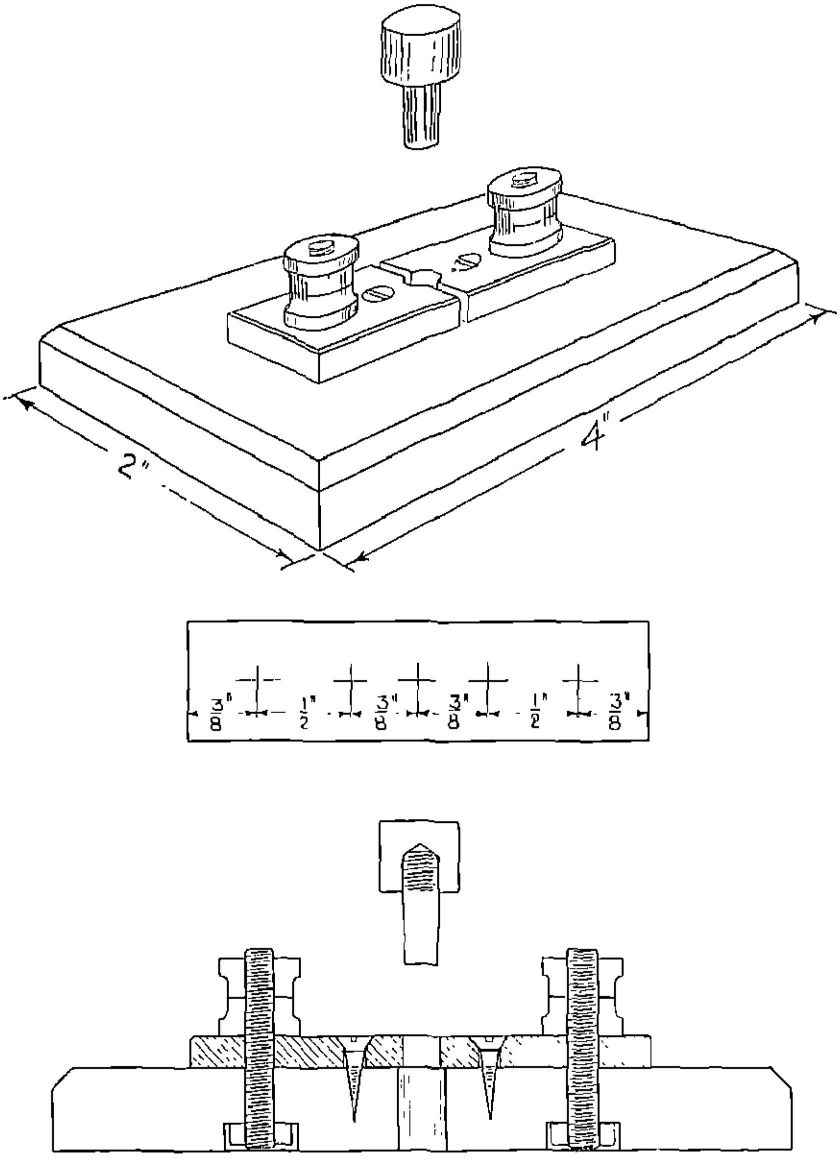

Fig. 26. A Plug-Switch

This is an exercise in accurate drilling through a brass bar.

worth threads, widely used in more general work, are particularly useful for screw sizes of ¼ in. and over, but since apparatus construction rarely involves anything over ¼ in., which is about the 0 B.A. size, the four mentioned above will suffice in nearly every case. 2 B.A., and 4 B.A., are the most useful. *Terminals for electrical apparatus* are generally found in these sizes, and the screws and bolts are sufficiently large to be easily handled by boys, without being unduly large for the work they are doing. 6 B.A.

is a useful size for setscrews, etc. The drills and taps required in the preparation of metal for screw sizes smaller than 6 B.A. are delicate and need careful handling if breakages are to be avoided. A fair experience is needed before the "feel" will indicate to a boy when he is near the safe limit of load with very small tools of this type.

The use of taps.—These tools are needed to cut a thread on the inside of a hole. The hole is first drilled with an appropriate tapping drill which is the same size as the core of the bolt measured without the thread which it carries, Fig. 27.

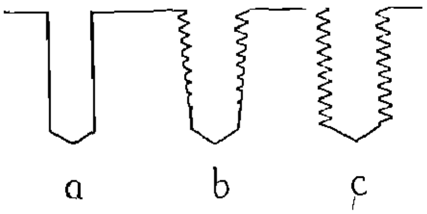

FIG. 27. TAPPING A HOLE

a. The hole, tapping size.
b. Thread cut with a taper tap.
c. Thread finished with a plug tap.

This leaves enough metal round the hole to take the thread. To start the thread, fit the "taper tap," which is ground away towards the point, into the tap-wrench and insert the tapered end into the hole. It just fits since the cutters have been ground away. Screw it down into the hole under a steady pressure and make sure that the tap is kept constantly in line with the axis of the hole, otherwise the screw will be slewed over to one side by the "drunken" thread. When the tap has achieved a firm grip, showing that the thread is well started, turn it back through about 45° after every half turn to clear the cutters of the turnings which are being piled up in front of them.

If the hole has been taken right through the metal the taper tap may be run through to a joint beyond the taper, when the cutters will be making a full thread. Sometimes, however, a thread is needed in a bottomed hole through which the tap cannot pass completely, as in Fig. 27. In this case the tapping hole is drilled a little deeper than the length to be threaded, Fig. 27 *a*. The taper tap is then worked into the hole just as far as it can go without touching the bottom of the hole, Fig. 27 *b*. It is important in this operation that the tap should not reach the bottom, for when it does, any further turning will begin to strip the thread. One should remember, too, that the metal turnings accumulate in the hole. They have the effect of raising the floor and preventing the progress of the tap earlier than might be expected. The tap should therefore be removed and the hole cleared at intervals. The thread, having been begun with the taper tap, may now be continued almost to the bottom of the hole, Fig. 27 *c*, by using the "plug tap," which cuts a full thread throughout its length. As in drilling, no oil is needed except with soft iron, mild steel, and the higher carbon steels.

The use of dies.—To cut an outside thread on a rod or filed tenon (Fig. 20), fix the metal upright in a vice and file a short taper at the end to allow the die to run on.

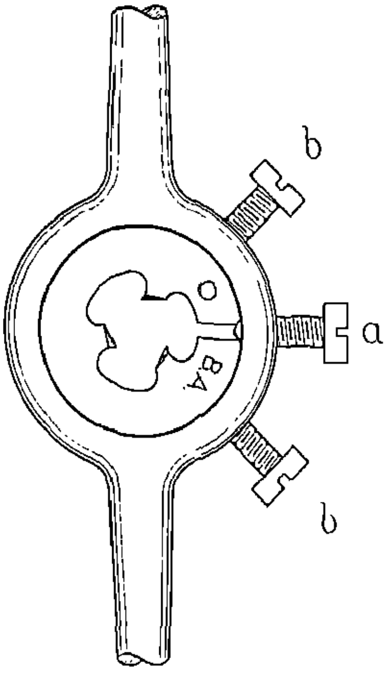

FIG. 28. A STOCK AND DIE

a, *b*. Screws.

Fit the die into the diestock so that the inscription remains visible and grip it in position by tightening the screws *a* and *b* in Fig. 28. According to the way these are tightened so one may modify the size of thread within narrow limits. For example, if the die is cutting a thread which is a shade too small, the cutters may be sprung open slightly by tightening the central one (Fig. 28*a*) which becomes wedged in the slot provided in the die. On the other hand, when the die becomes slightly worn and incapable of making a sufficiently deep cut, the cutters may be brought in a little by tightening the other two screws, leaving the central one somewhat slack. Having placed the die in position in the stock, turn it face downwards on to the tapered end of the rod or tenon, and begin to screw it on. As with tapping, care must be taken to see that the thread is running true,—that the stock is revolving always in a horizontal plane,—and that the tool is run backwards a little every half revolution to clear the cutters. The reason for turning the die face downwards to make the thread is that the cutters are given a clearance on their trailing edge. This is shown in Fig. 28. It is useful to have $\frac{3}{16}$ in. and $\frac{5}{32}$ in. rod in stock to take 2 B.A. and 4 B.A. threads.

A joint between two sheets of metal.—This may sometimes be made advantageously by the method shown in Fig. 29.

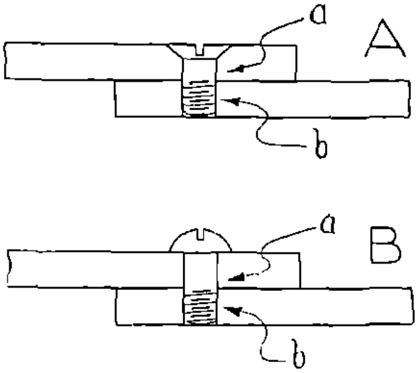

FIG. 29. PLATES JOINED BY A SCREW

A. Countersunk screw.
B. Round head screw.
a. Hole made by clearing drill
b. Hole made by tapping drill

The hole, *a* (Fig. 29 A), is made with a clearing drill to allow the free passage of the screw, and may be countersunk if a flush finish is required. The hole, *b* (Fig. 29 B), is made with a tapping drill and is tapped with the appropriate thread. It is advisable to drill both holes the tapping size first, with the plates gripped together in a vice, and then to run the clearing drill through the upper one. This method of joining can only be used when the lower sheet of metal is thick enough to take at least three full threads of the screw size used.

Riveting.—$\frac{1}{8}$ in. and $\frac{3}{32}$ in. copper and soft iron rivets are frequently useful, offering as they do a simple method of making a strong

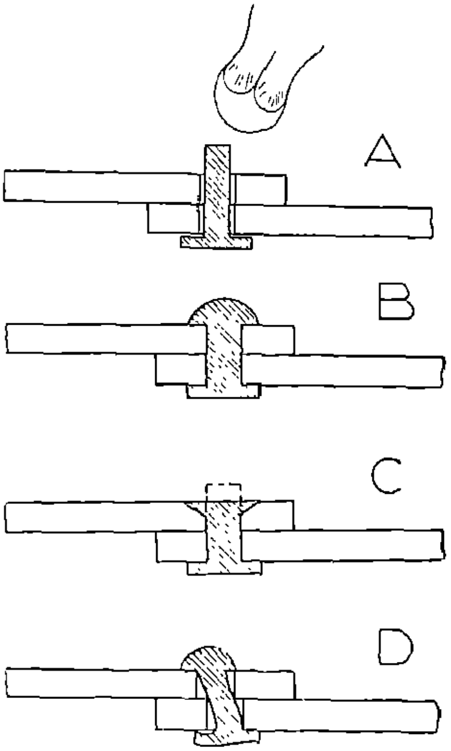

FIG. 30. RIVETING

A. Rivet ready for burring—the clearance is exaggerated in the diagram.
B. Rivet expanded to fill the hole and finished with a round head.
C. Countersunk head.
D. The result of a loose fit.

joint when perhaps the metal cannot be soldered, or when the joint will need to stand up to heat treatment afterwards.

First drill the holes with a $\frac{1}{8}$ in. or $\frac{3}{32}$ in. drill, thus ensuring that the rivets shall be a tight fit even before being burred over. This is important, as otherwise the rivet will bend, will not form a regular head, and will throw the plates out of line, Fig. 30 D.

Push the rivet through the holes and then, with the base of the rivet on a firm iron anvil such as a section of a girder or an old flatiron held in a vice, punch the plates well together with a "rivet sett." Then, with the ball pane of a hammer, burr over the edges lightly at first and then with rather heavier blows, working round the circumference of the rivet evenly to form the head as in Fig. 30 B.

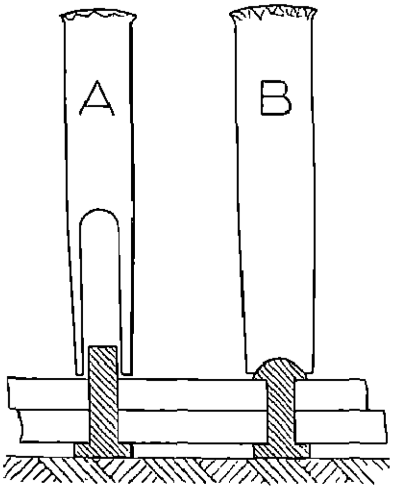

FIG. 31. A RIVET SETT (A) AND A RIVET SNAP (B) BOTH PARTLY SECTIONED

This may be given a finer finish by shaping it with a "rivet snap." Both copper and iron rivets of such sizes as we are likely to need are easily worked cold. They may be obtained with heads of a variety of shapes, the flat and half round being the most generally useful. If a flush finish is required, the face of the plate may be countersunk (Fig. 30 C), the rivet burred over as before, gradually to fill the recess, and the spare metal removed with a file. Countersunk heads are available should a flush finish be required on both sides of the joint.

A bimetallic strip offers a good exercise involving heat treatment of steel and riveting, Fig. 32.

First heat an old hacksaw blade to bright redness throughout its entire length, allowing it to cool slowly. This annealing softens the metal sufficiently to allow the teeth to be filed away and holes to be drilled at intervals. Clean up the blade with emery after filing, and mark centres at spaces of about 1 in. down the middle of the blade so that the first and last centres are about $\frac{1}{2}$ in. away from the holes already in the blade. Drill the series of $\frac{3}{32}$ in. holes. Next cut a strip of brass, about the same gauge as the steel, fit it to the saw blade allowing about $\frac{1}{16}$ in. excess brass on each side. Drill the first only of the $\frac{3}{32}$ in. holes and rivet the two strips together. Using the drilled saw blade as a template, or pattern, drill the brass and rivet at each hole in succession before passing on to the next, at the same time taking care not to bruise the brass during riveting. This method is suggested because the brass stretches under the hammer more easily than the steel, and if the brass is drilled throughout before beginning the riveting it may bulge between the rivets and impair the efficiency of the strip.

Several arrangements can now be employed to make use of the reaction to changes of temperature. The bimetallic strip may serve, with the brass face uppermost, as a *fire alarm* (Fig. 32 A) by including it in series with a bell and battery. In this case the strip itself acts as a conductor. By warming it with a small bunsen flame it will bend sufficiently to close the circuit and allow the bell to ring. It will be advisable to cover the baseboard with a thin asbestos sheet to protect it from damage by accidental heating. To arrange the strip as a *current interruptor* operating a flashing light, the brass surface must be underneath and there must be no connection between the terminal and the strip. In Fig. 32 B, therefore, remove

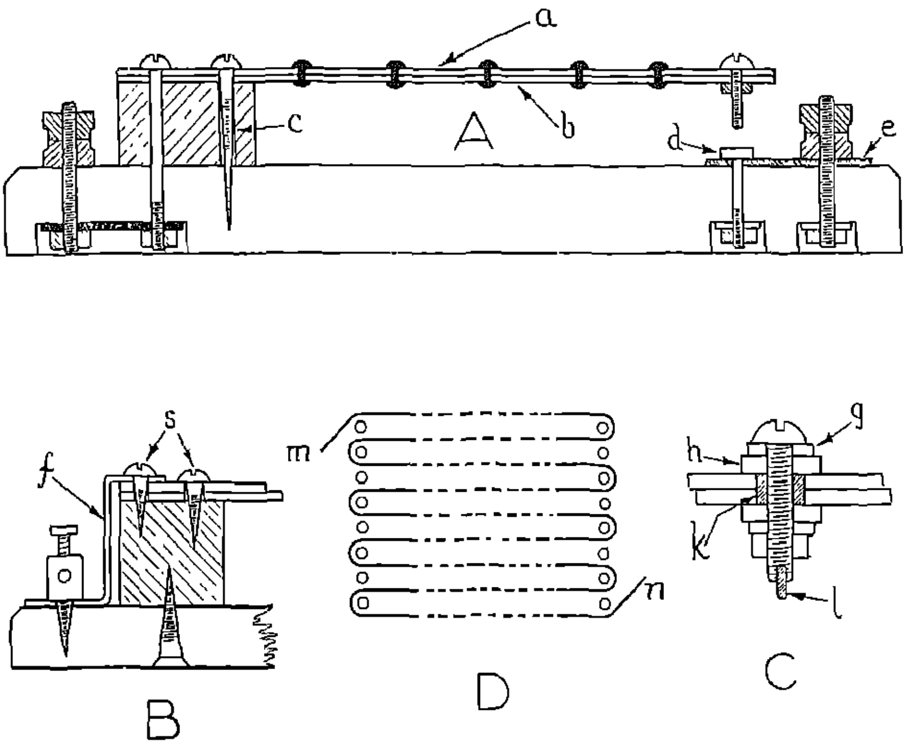

FIG. 32. A BIMETALLIC STRIP USED AS A FIRE ALARM

A. Section through the final assembly.
  a. Brass.
  b. Iron.
  c. Adjusting screw.
  e. Brass strip connecting the contact, *d*, with the terminal.
B. A simple alternative mounting.
  f. Brass connection.
  s. Mounting screws.
C. An insulated contact.
  g. Brass washer.
  h. Ebonite or fibre washer.
  k. Valve rubber sleeve.
  l. Silver solder point.
D. *m and n. Ends of iron wire.*

the brass connection, *f*, and turn the top surface of the strip to the bottom, reversing also the contact bolt. Give the strip two coats of cellulose black or cylinder black as a heat proof insulating medium. Now drive two rows of gramophone needles in a piece of wood, the rows being separated by a distance 1½ in. or so less than the length of the strip, and wind some 32 g. iron wire, grid fashion as in Fig. 32 D, up and down between the needles. Invert the wooden frame and lay a length of insulating tape on what is now the upper side of the grid between the rows of needles. Then, holding the strip just below the grid, ease the wire down the needles on to the brass face of the strip so that it is sandwiched between the insulating tape and the brass. If well pressed down, the tape will hold the wire in position, particularly if the ends of the tape are bound in place with a few turns of cotton. The end, *m* (Fig. 32 D), of the iron wire is taken to the contact bolt and the other end, *n*, goes, without making contact with the strip, directly to the terminal. On no account should the metal strip be allowed to short circuit the iron wire.

To light a 6 v. lamp with the interruptor in series, 8 or 10 v. will be needed. To give this apparatus the careful adjustment necessary each mounting screw (Fig. 32 B *s*) may be tightened or slackened a little so that flashes of about 15 seconds are obtained. Owing to the springy nature of the strip the interruptor must be guarded against vibration by mounting it on a pad of felt or cotton wool. Further examples of the use of such compound strips may be arranged by amplifying the movement of the free end, either through a light pulley gearing or by fitting to it a toothed quadrant operating a gear wheel with a pointer to show the movement. Fig. 32 C, shows a method of insulating the contact point from the metal of the strip in cases where this precaution is necessary. The hole is enlarged to give a good clearance round the bolt. Then before the bolt is inserted, two washers, the first (*g*) of brass and the second (*h*) of thin ebonite or vulcanised fibre, are slipped on and held in position by a rubber ring (*k*) cut from cycle valve tubing. After insertion, two more washers are added as before and the whole system secured by a nut. Should such a contact be needed for fairly heavy or intermittent currents a short piece of 20 g. silver solder wire (*l*) should be sweated into a hole drilled in the end of the bolt. This makes contact with a small plate of the same metal soldered to the head of the bolt below. (See the section on *Soldering*.)

Heat treatment of metals.

Explanation of annealing.—When metal is being subjected to distortion in its cold condition, as by bending or hammering, it becomes "work hardened," in which state it is usually brittle as well as hard and is liable to fracture. This condition is intentionally produced in the making of brass contact brushes and is found to a moderate degree in "spring brass" and in cold drawn or rolled brass and copper. It is usually advisable, however, to remove both the hardness and brittleness by the process of annealing.

The work hardened condition is the result of changes in the crystalline structure of the metal. Normally, a piece of metal is composed of microscopic crystalline masses, each crystal being endowed with planes along which it is most likely to split. These are planes of cleavage or planes of slip. When permanently distorted, say by a hammer blow, the energy of the blow is concentrated to produce a slip along one such plane, thus throwing the atoms in the neighbourhood of the slip out of their proper place in the crystal structure, jumbling them in random arrangement. Such a haphazard arrangement of atoms does not possess the malleability of the orderly array, and thus each crystal mass becomes laced across with bands of brittle, hard and non-malleable atomic layers. It is along such slip bands that fracture is likely to occur.

By raising the temperature of the hardened metal its atoms are given an increased mobility which allows them to shuffle into their proper places in a regular crystalline formation. In this way the metal is again rendered crystalline throughout, with the consequent return of its malleability and the loss of much of its hardness and brittleness.

Annealing temperatures.—Each metal requires its own heat treatment as outlined below.

Soft iron and mild steel.—Heat to bright redness, about 900°C., and hold at that temperature for a minute or two, then allow the metal to cool down slowly in the warm air above the flame. A rod or strip can be annealed by feeding it forward very slowly through the hottest part of a bunsen flame so long as the part in the flame is constantly at a bright red heat.

Tool steel and spring steel.—These do not require quite such a high temperature; 750°C. is high enough. More prolonged treatment at this full red heat, or several reheats, is usually needed to remove the hardness from such an article as a hacksaw blade. Slow cooling is essential.

Brass.—This should be heated to dull redness for a minute or so and then left to cool. It may be quenched in water to save time.

Copper.—This is heated to cherry redness and quenched in water.

Aluminium.—This requires heating to about 300°C. Two methods of gauging the correct temperature will probably be found helpful. The first is to rub the surface of the aluminium at intervals while it is being gently and uniformly heated, with a wooden splint. At first one can feel the "bite" due to friction between the metal and the wood, but later the splint begins to slide much more freely over the aluminium, becoming slightly charred at the same time. When this occurs the annealing temperature has been reached. Leave the metal to cool.

A second method is to rub a little soap over the metal and heat gently until the soap shows signs of charring. The first is the easier way, and is quite satisfactory.

Zinc.—This is brittle when cold, and has a very low annealing temperature. Instead of removing the hardness it is advisable to prevent its occurrence by working the metal at about 50°C.–60°C., when it is as hot as one can usually handle.

Bending without annealing.—Thin sheet metal, up to about 16 g., and rods up to about $\frac{1}{8}$ in. diameter may usually be bent to a sharp right angle without appreciable weakening. Once made, the bend should not be modified much without annealing beforehand. With thicker sections it is advisable to anneal once, or even twice, during the making of a sharp bend, though the need for heat treatment may be obviated if the metal is bent over a former of gas barrel or iron rod instead of over the sharp edge of the vice jaw.

Hardening of steel.—Tool steel, silver steel, and spring steel, which contain about 0·6 % or more of carbon, become very hard and rather brittle when quenched suddenly from full red heat (750°C.–800°C.) The degree of hardness produced depends both on the percentage of carbon present in the steel, and on the speed and extent of the quenching. For extreme hardness, the steel at red heat should be plunged immediately into cold water and moved about vigorously until quite cold. When a more moderate hardening is desired cold oil may be used as the quenching medium. Olive oil is found to be quite satisfactory. The hardness is a result of a micro-crystalline condition which, while usual at high temperatures, is not normal at room temperature. Brittleness is due to the stresses set up in the metal as a consequence of the extremely rapid cooling during the quench. Such stresses may be relieved, and the brittleness reduced, by tempering, with little effect on the hardness of the metal.

Tempering of hardened steel.—The general method of tempering, apart from the use of carefully controlled ovens, is to clean up the metal after quenching, to produce a bright surface, and to heat it gradually and evenly. As the temperature of the steel rises the colour of the oxide film changes from a pale straw tint through many phases to a deep blue, the colour indicating to an expert the temperature of the metal. For such small articles as we shall need in science handicraft, the following method, needing little experience, is quite satisfactory.

Tempering of springs.—Quench the steel from full redness in a bowl of cold olive oil. Drain off the excess of oil and then warm the steel above a bunsen flame until the residue of oil catches fire. Remove it and allow the oil to burn away of its own accord, then cool off again in the oil bath. The temperature at which the oil burns is a good average for tempering. If sufficient oil is not available, the quenching may be done in cold water. In this case the steel should then be thoroughly dried and dipped in olive oil, the subsequent draining of excess oil not being carried to quite the same extent as with oil quenching.

Examples of heat treatments.—Knife blades and scalpels for biological work can be made by filing up a length of annealed hacksaw blade, hardening and tempering it. It is then finished off on a grindstone and sharpened on an oilstone. Lengths of $\frac{1}{8}$ in. silver steel rod may be filed or ground to a point which is then hardened to make scribers for marking out metal. A final touching up on an emery wheel gives a sharp, lasting point.

A magnetic compass needle.—This is easily made from a 3 in. or 4 in. length of clock-spring. Cut the required length with shears and anneal it well. Flatten it by light hammering and by bending it with the fingers, clean it with emery cloth and mark it out as shown in Fig. 33 A.

At the middle point make a dent with a centrepunch and bend the strip to the shape shown in diagram B, clipping the ends with shears to form points. If the strip is held in a vice so that the marked line is level with the edge of the jaws, the metal can be pushed over with a finger to give a bend at the right place. Test the needle for balance, and adjust by filing from one end. It is now heated, quenched and tempered as described above, the final balance being achieved if necessary by grinding down the points on an emery wheel. If a bunsen flame is the only source of heat, each end of the needle may be treated separately so long as the end which is not being heated is wrapped with wet rag to prevent its being affected by conducted heat. The needle can be magnetised either in a solenoid or by stroking with a permanent magnet.

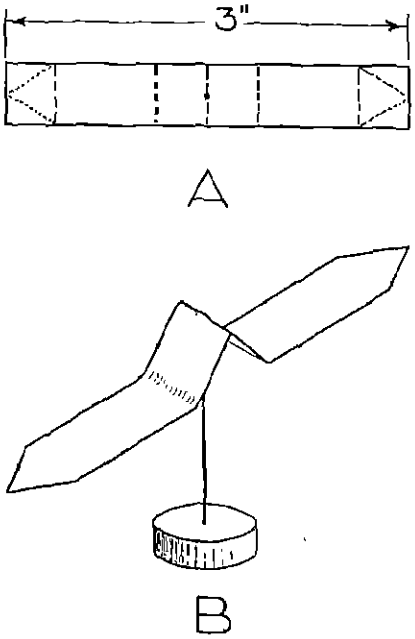

FIG. 33. A MAGNETIC COMPASS NEEDLE
A. Annealed clockspring marked out.
B. The finished article.

Casting.—For the most part there is little call for iron, brass or aluminium castings in science handicraft, though they may be useful for heavier bearings, girders, etc., since the high temperatures at which these metals must be poured operates against their being used for this purpose in most schools. Where the school is situated near to a foundry it is often possible to get castings made quite cheaply on the few occasions when they may be required.

Lead castings, for such things as flywheels, may easily be made in the laboratory. It is not essential to have a wooden pattern made specially for the job for in most cases some oddment may be found to serve as a starting point. In the case of a flywheel, for example, a cast iron wheel from a toy will do. File the central hole to a square to take a short length of, say, ½ in. square brass bar. Fill in one of the spaces between the spokes with modelling wax if a balance weight is needed in the flywheel, and there we have the pattern. To make the mould, cut four 1½ in. square bars of plasticine and stick them down on a sheet of glass to form a square, shallow, watertight trough. Lightly paint the glass floor of the trough with a solution of vaseline in petrol, leave it a while for the petrol to evaporate and give the pattern a coating of the same solution. Mix some plaster of paris to a creamy paste with water and pour it into the trough so that it is rather less than half full. Then place the pattern so that it is bedded down in the plaster to its halfway line, and keep it in position for a little while until the plaster has set, Fig. 34.

When the pattern is in position and before the plaster has set, make three depressions in the plaster near the outside edge, about

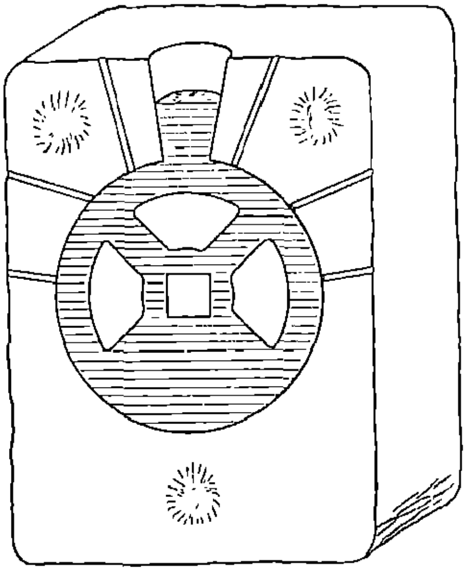

FIG. 34. CASTING IN LEAD

One half of the plaster mould is shown, the shading representing the lead.

$\frac{1}{4}$ in. deep, with a sealed glass tube or rounded rod.

After the plaster is hard, coat its surface and that of the exposed half of the pattern with the vaseline solution, leave a little while for the petrol to evaporate, and fill the trough with freshly made plaster paste. After half an hour or so the plasticine walls may be taken away, the two halves of the mould separated, and the pattern removed. Make sure that the plaster has properly set before interfering with the mould—some samples of plaster set more slowly than others. The depressions made by the glass will now have formed keys on the upper half of the mould to enable the two halves to register correctly. Scrape a funnel-shaped hole, part in each half of the mould and leading into the cavity, to serve as a means of introducing the molten lead, and make a few shallow radial scratches on one half of the mould to allow air and steam to escape during the pouring. To reduce the amount of steam produced it is worth while drying out the mould as far as possible in a drying oven at about 90°C.

To make the casting.—Wire together the two halves of the mould and stand them in an iron tray provided with sides to confine the lead if the mould should break or the metal be spilled. The lid of a large biscuit tin standing on an asbestos sheet does very well. Melt some scrap lead or old composition tubing in a metal ladle, scrape aside the oxide scum, and straightway pour the metal slowly and continuously into the mould until the funnel is full. Tap it lightly to make sure that no blowholes are left in the casting, then leave it to set. Take it to pieces when cold. Frequently the plaster will crack after the first use, but so long as the pieces can be securely wired together again it may still be used for further castings.

The brass bush is prepared by cutting the requisite length of brass bar, drilling it

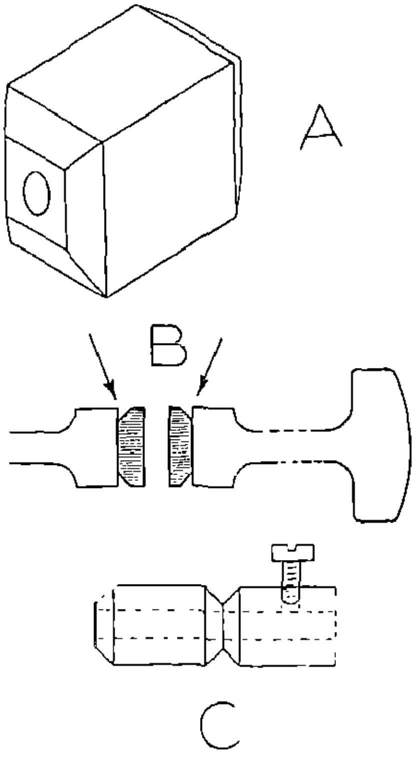

FIG. 35

A and C. Alternative forms of brass bush for a lead flywheel.

B. The lead is punched over or soldered as shown by the arrows.

to take the axle, and bevelling the edges at each end as in Fig. 35 A. The bevel allows the lead to be forced over with a round headed punch to grip the bush in position (Fig. 35 B), or as an alternative the space may be filled with solder. As it is usually desirable to fix a flywheel by means of a setscrew the bush may be cut to extend $\frac{3}{8}$ in. beyond the wheel, a Vee slot being filed round it in place of the bevel, Fig. 35 C. The extension is then drilled and tapped to take a setscrew. The lead can be trimmed with a knife and painted.

As a simple substitute for a proper casting, the lid of a tin may be filled with lead and mounted on the axle. Punch a hole from the outside in the centre of the lid to take a length of $\frac{3}{8}$ in. diameter brass rod (*a* in Fig. 36) which has been drilled for the axle and provided with a setscrew (Fig. 36 *b*), and into which a short length of screw (Fig. 36 *c*), may be fixed to key the bush in position. Fix the axle in the bush, support it vertically with a retort stand, and under the lid place a piece of wood with a hole to accommodate the projecting bush. When lid and axle are squared up, pour in the molten lead, Fig. 36 *d*. To balance the wheel, drill holes (*e*), in the lead with a $\frac{1}{4}$ in. or $\frac{5}{16}$ in. drill. A touch of solder may be added round the bush at *f*, but it is not really necessary.

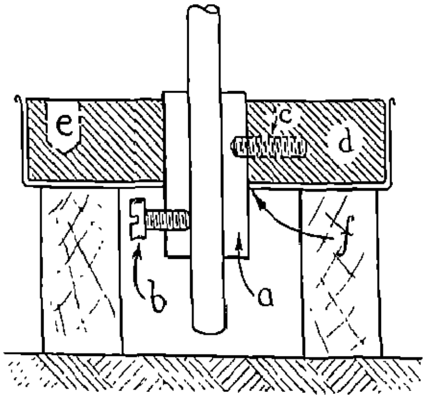

FIG. 36. ANOTHER TYPE OF FLYWHEEL

a. Brass rod.
b. Setscrew.
c. Short length of screw.
d. Lead.
e. Hole drilled in lead.
f. Solder.

Coil springs.—These are frequently needed in apparatus making, and may be wound quite simply with the aid of a wheelbrace gripped horizontally in a vice with the chuck pointing to the left. A series of steel rods of various thicknesses and about 3 in. long should be kept as formers, and several gauges of steel wire should be available for use. Select a rod and a coil of steel wire according to the size and strength of the spring required. Fix the rod in the chuck of the brace and clip the end of the wire between the rod and one of the jaws of the chuck, which is then screwed up firmly. Holding the other end of, say, a 12 in. length of wire with pliers, pull it fairly hard away from the brace and slightly back towards the handle so that the coils lie touching one another during winding. Then rotate the chuck by turning the wheel of the brace in a clockwise direction viewed from above. For most purposes the spring will need no heat treatment, but if it should, harden and temper it as described above. If an open coil spring is required in place of the close coil which results from the foregoing method, it is much better to strain the close coil to the degree of openness needed,—before heat treatment if any,—than to attempt to wind the open coil directly on the former. A lathe can, of course, be used in place of a wheel-brace.

Staining and polishing of timbers.—See page 443.

Simple glassworking.

Cutting.—To cut sheet glass with any degree of certainty one needs a diamond glass cutter. Fair results are obtainable with a hardened steel wheel, but reliance cannot always be placed on it. Find by trial the best angle at which to hold the cutter, then with the glass laid on a flat surface covered with a few sheets of paper score the line along which the cut is to be made, with one steady stroke, using a rule as a guide. Lift the glass without turning it over and tap immediately below one end of the scored line with the metal head of the cutter, when a crack starting at that end may be continued through the length of the cut. Curves should be scribed with the aid of a radius string.

Tubing is generally cut by means of a triangular file or a glass knife. Sections up to ¼ in. may be cut by scoring round the tube at the required point, placing both thumbs as near the line as possible, with the fingers wrapped round the tube, then bending and pulling apart at the same time. This method is probably well known to all readers. Tubing over ¼ in. requires more care, since the break may be irregular and the glass may even split along its length with the risk of a deep cut. Wrap a piece of paper round the tube to serve as a guide and make a well defined cut right round the tube. Tapping sharply on the line will often start the crack in the right place, but a useful alternative is to use a hot iron wire. The wire, about ⅛ in. diameter, is applied red hot along part of the scored line and held there for a few seconds. Removing it, immediately touch the heated spot with a wet finger just for an instant. The crack thus started can be made to follow the scratch with the hot wire, touching it, if necessary, as before. In this way, any size of tubing may be cut. After cutting, it is advisable to heat the end of the tubing until the sharp edges are rounded off.

Grinding.—Emery powder or cloth, moistened with paraffin or turpentine, are efficient abrasives for glass. If the base of a prism, glass block, or cylindrical lens is ground, the path of a ray of light may be seen as it passes through the glass. To do this, sprinkle some emery on a waste sheet of window glass, moisten it, and rub the prism or lens on it, keeping the surfaces in flat contact all the time. Vary the direction of rubbing occasionally. Grinding paste, sold at garages for grinding in valves, may be used and will be found convenient for grinding stoppers and ill fitting glass stopcocks. The abrasive should be washed away thoroughly when the process is finished.

Bending of tubes and rods.—Adjust a batswing flame so that its breadth is about the same as the length of glass in which the bend is to occur. From above, lower the tube gradually into the flame along its major axis, rotating it steadily all the time, Fig. 37. Keep it in the luminous zone until it becomes plastic, when it may be removed from the flame and bent to the required curve. The coating of soot is easily wiped off when cool. Small diameter tubing and rod,—about ⅛ in. for example,—may be bent by heating in the outer cone of a bunsen flame.

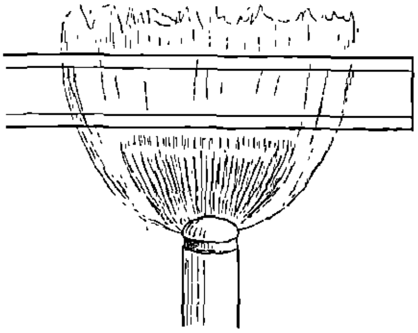

FIG. 37. GLASS TUBE IN A BATSWING FLAME

The blowpipe.—Fair results in the simpler glassworking operations can often be obtained by the use of a bunsen burner and a mouth blowpipe, but a blowpipe operated from foot bellows is highly desirable, and is essential for more complex purposes. It should be arranged so that both gas and air supplies may be easily and independently regulated.

Sealing.—To make a neat strong seal, heat the tubing with a small blowpipe flame, rotating it steadily, and draw it off to a point as shown in Fig. 38, at *a* and *b*.

Heat it again, just at the very end, touch the tip with another hot glass tube and remove from the flame, drawing off the spare glass at the same time. This gives a seal with a fairly uniform thickness of wall, Fig. 38 *c*. By inclining the tube into the

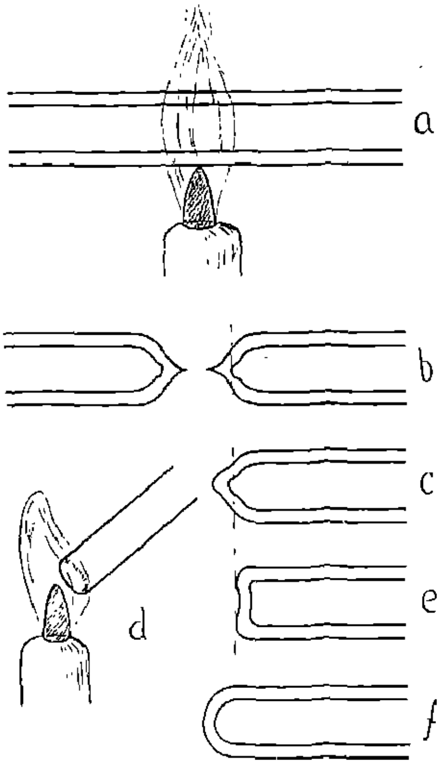

FIG. 38. STAGES IN SEALING A GLASS TUBE

a. Tube heated by small blow-pipe flame.
b. Tube drawn off to a point.
c. Seal with uniform thickness of wall.
d. Seal inclined into hottest part of flame.
e. Flattened sealed end.
f. End rounded off by blowing.

hottest part of the small flame, as shown in Fig. 38 *d*, and rotating it, the sealed end becomes *flattened* (*Fig. 38 e*) and will, in time, thicken up. Before this thickening happens, remove the tube and round off the end by blowing, Fig. 38 *f*. Anneal for a minute or so in the luminous flame obtained when the air blast is discontinued, and then set aside to cool.

The gradual warming up and the annealing at the end of the process are safeguards which should always be employed in glass working. A glass screen around the blow-pipe bench, to prevent draughts, is an advantage.

Joining tubes of the same size.—Seal each tube as above, as far as stage *e* in Fig. 38. Now round the end of each by blowing, (Fig. 39 *f*), and immediately flatten again (Fig. 39 *g*), this time heating and softening a little less glass than before, but enough to prevent the narrowing of the tube.

Successive flattenings and blowings will soon thin the wall of the rounded end without appreciably altering the diameter of the tube, Fig. 39 *i*. When the flattened end is fairly thin, a really hard and sharp blast of air will blow the end right out instead of rounding it, Fig. 39 *j*. If too much glass is heated, or if the blowing is not sharp and hard enough, the thinned end may be splayed out as at *k*, Fig. 39. It is difficult then to make a good joint. Close the other end of one of the two tubes either by sealing or with a small rubber bung or a piece of rubber tubing plugged with glass rod. The two tubes may now be joined. Bring them, rotating with their axes in the same line, into the edge of a large hot flame until the thinned ends just show signs of fusing. Allow the air blast to die down while the two ends are brought into the middle of the flame and gently pushed together, the

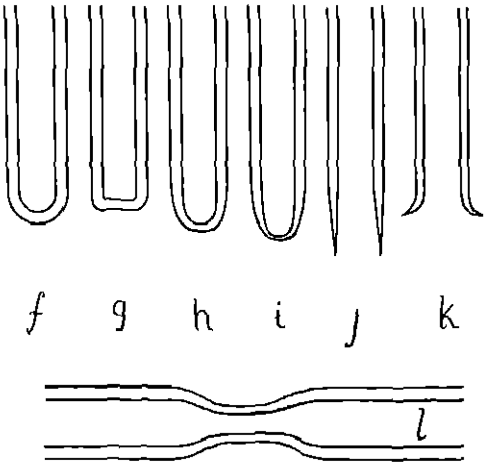

FIG. 39. PREPARATION FOR A STRAIGHT JOINT

f. End rounded off by blowing.
g. h, and *i.* *Successive flattenings and blowings to thin* the wall of the end.
j. Thin end blown out.
k. Ends played out.
l. Elongation maintaining walls of uniform thickness.

rotation ceasing only while the ends are being joined. Pull them apart a very little when joined, to prevent local thickening, and anneal in and above the luminous flame. This gives quite a good joint usually, but it can be improved by heating all round with a *small flame until the tubing just begins to* be reduced in diameter at the junction, and blowing it gently back to size out of the flame. With practice, this treatment ensures a uniform thickness of wall and produces a joint which is scarcely visible. When one tube is larger than the other it may be reduced to the same size by heating with a fairly large flame and rotating it without drawing it out very much. Only that elongation should be allowed which will maintain the walls of uniform thickness, Fig. 39, *l*. At this point it may well be stressed that *proficiency in glassworking comes only* through practice and the exercise of care and patience. It is well worth while spending a little time gaining a measure of skill in sealing and joining, to get the "feel" of softening glass and to learn its characteristics before attempting more difficult operations.

To make a tee joint.—Prepare a sealed tube, thinned at the open end (Fig. 39 *j*), and seal the crosspiece tube at one end. Warm up the latter in the middle and then heat it at one place with the point of a small flame until the glass begins to collapse, Fig. 40 *m*. *Blow it out gently to raise a small bulb at* the side, Fig. 40 *n*. Flatten the top of the bulb and blow it right out to make a hole (Fig. 40 *o*), surrounded by a thinned wall. Before attempting the joint, be sure that the prepared tube is the same size as the hole; if not, make another part and keep the rejected item for possible use on another occasion.

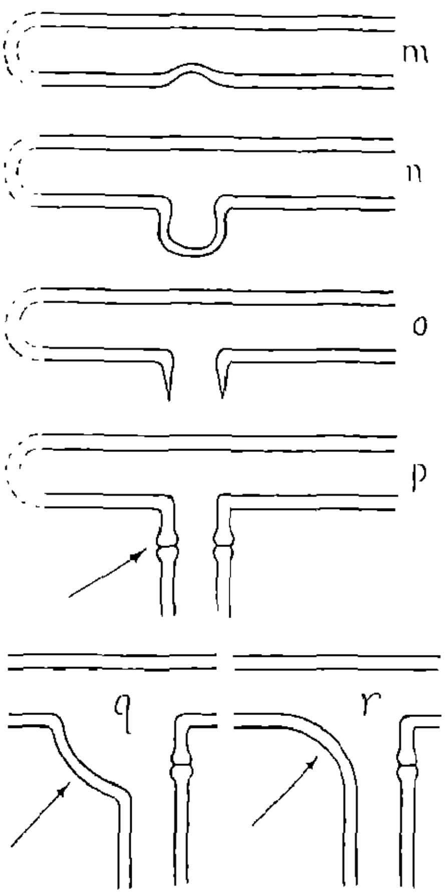

FIG. 40. MAKING A TEE JOINT

m. Sealed crosspiece tube heated at one place.
n. Glass blown out gently to raise a small bulb.
o. Top of bulb flattened and blown out to make hole.
p. Contact made right round the junction.
q. Joint blown out a little.
r. Bulb collapsed to a smoother curve.

To make the joint, heat the thinned parts as before at the edge of a fairly large blowpipe flame and bring them together in the flame with the diminishing air supply. It is essential *that a perfect contact should be made right* round the junction, Fig. 40 *p*. A small pinhole, resulting from incomplete adhesion, if noticed early may be covered with a small bead of glass put on in the flame from a length of capillary tubing. This will usually be found in plenty near the blowpipe bench. If unnoticed, the hole soon becomes enlarged beyond remedy when the surrounding glass is softened—a surface tension effect. After annealing the joint, (Fig. 40 *p*), for a short time, heat it with a very small flame in the angle of the junction and blow it out a *little at this point*, Fig. 40 *q*. *A little further* heating in the same place allows the incipient bulb to collapse to a smoother curve, (*r*), obliterating all sign of the junction there.

Repeat this treatment in the other angle, and at several other places, to smooth out the entire joint. At no time during the working should the glass be allowed to get cold.

A steam heater.—Take a 1 in. boiling tube and close it with a cork carrying a length of tube to serve as a mouthpiece. At the point *a*, Fig. 41, blow a hole and make a tee joint, using an arm which has been thinned at one end and sealed at the other. Blow a hole (Fig. 41 *b*) in the end of the tube, using the tubing through the cork as a mouthpiece. Closing this mouthpiece, seal on another thinned tube, left open at the other end (Fig. 41 *c*) to serve as the new mouthpiece. Cut off the end of the side arm and round off the edges. Remove the cork and replace it with another which has been bored to carry a ⅝ in. test tube. An object placed inside the test tube may now be heated by passing steam through the jacket, in at the side tube and out at *c*, Fig. 41. This apparatus will be found useful for specific heat experiments.

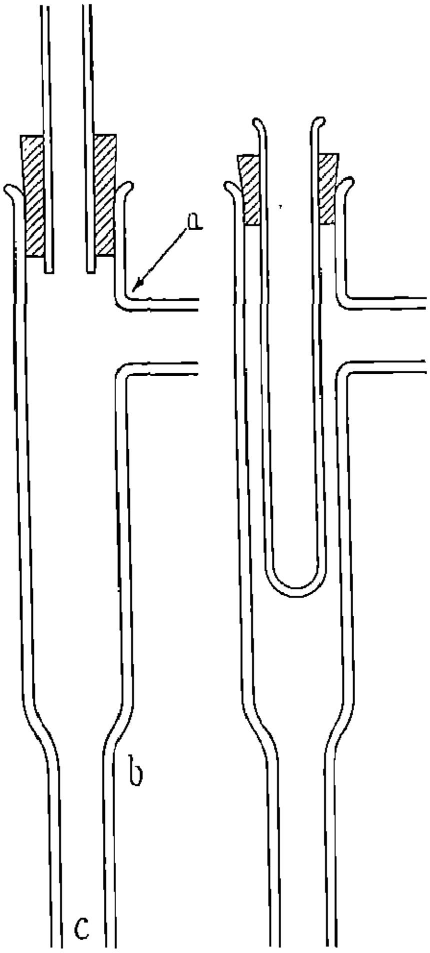

FIG. 41. A STEAM HEATER

a. Point to blow a hole and make tee joint.
b. End of tube.
c. Open end of second tube.

Blowing a bulb.—Having sealed a length of tubing, as in Fig. 38 *f*, a small bulb may be made on the end by heating the last ¼ in. or so, allowing it to thicken, and blowing it out. This method is, of course, well known and widely used, except that the initial sealing is not always done carefully.

If too long a lump of glass is allowed to form on the end in the hope of getting a large bulb, or if the zone of greatest heating is not maintained at the end of the seal, but is allowed to move along the tube, the sides of the bulb are usually thin and the bottom thickened like a lens, Fig. 42 *b*. The glass tube should be relatively cool, and rigid like a glassblower's metal blowpipe, while the sealed part represents the lump of glass at its working end. When a larger bulb is required, particularly with thermometer tubing, two small ones should be made as a starting point. First heat the end with a small flame and blow it out a little (Fig. 42 *c*), then with the same small flame applied a short distance further along the tube make a second bulb, Fig. 42 *d*. Using a flame large enough to take in both bulbs, blow the large one (Fig. 42 *e*). In this way the wall may be kept more uniform in thickness. It is essential to remember that tubes should be maintained in rotation throughout the heating, and should be turned down to the vertical position as soon as the heating ceases and blowing begins, otherwise the bulb will be lopsided. The making of a bulb in the middle of a length of tubing is an operation requiring rather more practice. The tube, sealed at one end, should be heated where the bulb is wanted and the ends eased in a little to shorten the tube by a small amount while thickening the walls in the heated part (Fig. 42 *f*). When this is done, put the tube in a vertical position and blow the bulb (Fig. 42 *g*). The difficulty is to heat the central part sufficiently without producing a twist in it due to unequal turning. The two hands must work together; that is what requires the practice.

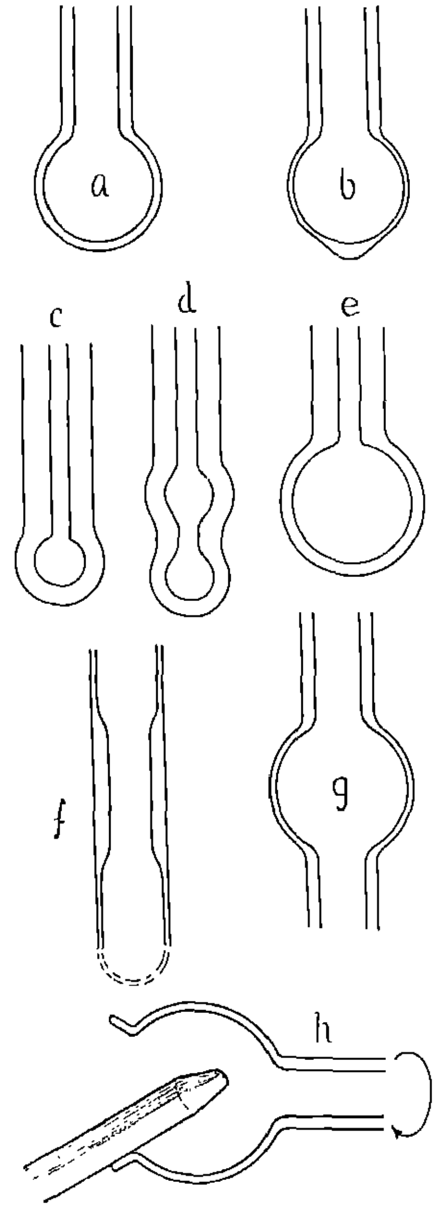

Fig. 42. Blowing a Bulb

a. Bulb on sealed end of tubing.
b. Result of too long a lump of glass being allowed to form on the end of the tube.
c. First of two small bulbs to make one large bulb.
d. Second small bulb.
e. Large bulb blown from two small ones.
f. Walls thickened for bulb.
g. Bulb blown from (*f*).
h. Mouth of funnel being shaped.

If an oxy-gas blowpipe is available—it must have a metal or quartz jet—pyrex tubing may be used instead of soda glass. It is easier to work and does not need to be annealed; it is therefore a good material to use for practice, though its higher cost may be prohibitive in many cases.

A thistle funnel.—This may be made from a bulb tube by flattening the end of the bulb in a flame and blowing it right out.

The rough edge left is then rounded off in a large flame and the mouth of the funnel shaped by rotating it against a carbon rod while still soft, as at *h*, Fig. 42. An electrode from an electric arc lamp serves the purpose very well.

Shaping with carbon.—Electrodes of various sizes will be found useful for opening the mouth of a tube and for similar operations, while a charcoal block may be used to produce flat surfaces.

Weighing bottles, for example, may be made from broken boiling tubes by sealing them, flattening the end in the flame, as in Fig. 38 *e*, and then pressing them gently on a charcoal block to ensure that the base is flat enough to allow the bottle to stand firmly. The chief thing to avoid in this operation is the production of a thick base. The rounded end of the sealed tube should therefore be worked thin by the method shown in Fig. 39, *f–i*, before flattening.

Sealing platinum into glass.—Seal a length of glass tubing as in Fig. 38 *c*. Heat it at the tip with a very small flame and, touching it at this point with a heated glass rod, draw it out a little way, Fig. 43 *a*.

Heat the tip again and blow a small bulb (Fig. 43 *b*) which is then flattened and blown

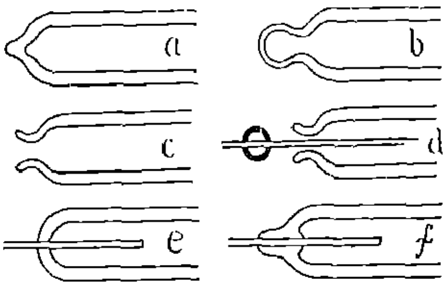

FIG. 43. SEALING PLATINUM WIRE IN A TUBE (*a* to *e*)

f. Such an accumulation of glass might cause a crack.

out, Fig. 43 *c*. Heat the platinum wire at the place where the seal is intended to occur, and fuse on to it a small bead of glass, using some waste capilliary tubing to provide the bead. This ensures a good glass-platinum joint. In the flame, put the bead into the hole (Fig. 43 *d*), and fuse the glass together. The end should then be blown to a rounded shape (Fig. 43 *e*) to avoid the accumulation of glass at the seal (Fig. 43 *f*). In a similar way the platinum electrodes may be sealed into the side of a tube, as in a eudiometer.

Welding of platinum.—This seems to be an appropriate place at which to mention the welding of platinum, which is done without the aid of a flux. It is really a two-man job. One person holds a length of wire lying on the face of a square of foil about $\frac{1}{10}$ in. above the surface of an anvil, while the second heats the platinum to white heat with a blowpipe flame, or bunsen flame, and welds the two parts together with one smart blow from a small hammer. This is all that is required.

A water voltameter.—An electrode is shown in section in Fig. 44. The platinum foil (Fig. 44 *a*), is welded to a platinum wire, which passes through a sealed tube (Fig.

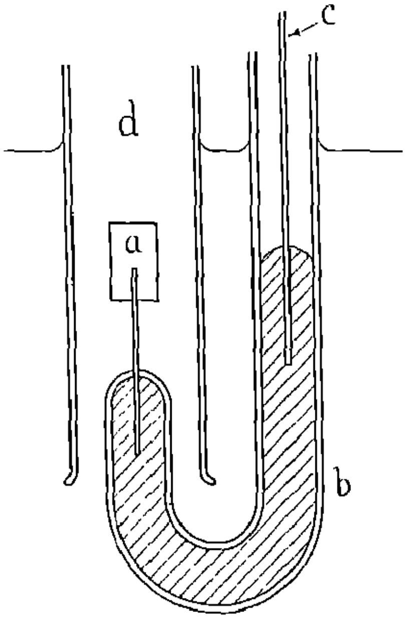

FIG. 44. AN ELECTRODE FOR A WATER VOLTAMETER

a. Platinum foil.
b. Sealed tube.
c. Bared copper wire.
d. Test tube.

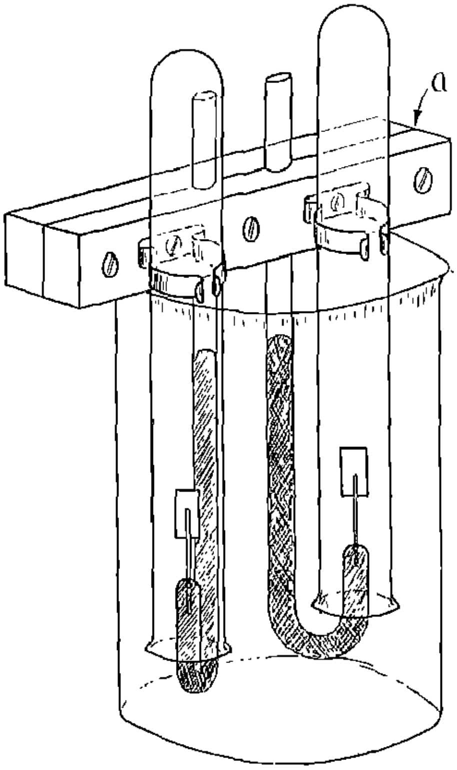

FIG. 45. A WATER VOLTAMETER

a. Two strips of ebonite or bakelite.

44 *b*) into mercury. A bared copper wire (Fig. 44 *c*) dipping into the mercury, connects the electrode to a battery. A test tube (Fig. 44 *d*) stands over the foil.

In Fig. 45 two such electrodes are fixed in holes drilled between two strips of ebonite or bakelite (Fig. 45 *a*), bolted together, on the face of which are fixed two spring clips of a size to take a test tube. The assembly is rested across the mouth of a beaker of electrolyte. The test tubes are filled with the electrolyte, inverted and clipped into position. Copper wires from the battery, dipping into the mercury, complete the circuit.

BASIC STRUCTURES AND MECHANISMS

Some features are found to be common to many of the models dealt with in science handicraft, and a knowledge of their construction and scope is a good starting point from which to approach the design of apparatus. Several of the more important ones are dealt with here.

Woodwork joints.—Fig. 46 shows some of the simple joints which are useful in apparatus construction. While the sample given is not comprehensive, it should cover most of the needs in a normal course of science handicraft, and it is probable that the teachers who find the need for more will be those who already have a close acquaintance with woodworking operations. To a great degree, the cutting of joints may be avoided by recourse to iron angle brackets and screwed face plates, but in most cases at the sacrifice of appearance and rigidity. The time spent in constructing a sound joint is time well spent.

Lapped joint.—Fig. 46 A. This is used in the building of a framework such as is found in the mechanics frame, Fig. 6. It is quickly made, since it can be cut entirely with a tenon saw, and when constructed accurately will be found to give good service. Mark out and cut one lap first and then, fitting it to the other piece of wood, mark out the other lap from it, taking care in this, as in all such work, to make the sawcut on the waste side of the marked line. The joint is secured with both glue and screws, the latter passing freely through the first lap to grip the second, thus allowing the joint to be pulled up tightly.

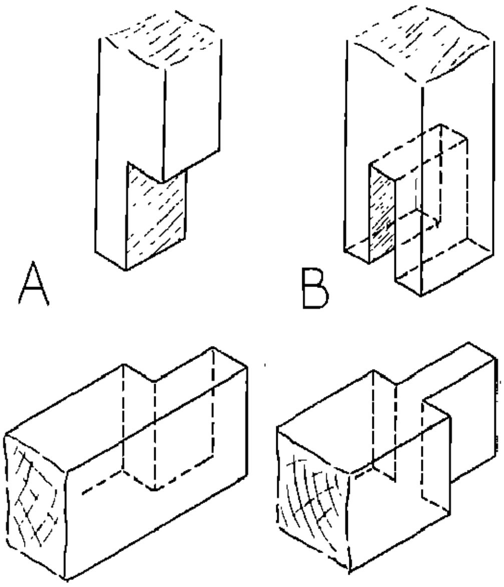

FIG. 46

A. A lapped joint.
B. A bridle joint.

Bridle joint.—Fig. 46 B. This may be used as an alternative to the lapped joint. It is rather more difficult to make, but gives greater strength and rigidity. After marking out the tongue, or tenon, on one piece of wood, mount it vertically in a vice and cut the sides of the tenon with a tenon saw. Next grip the wood horizontally and cut the two shoulders. Before cutting the other piece check the measurements and decide on which side of the marked lines the cuts are to be made. Then saw down the sides of the slot to the required depth and pare away the waste with a chisel. A good deal of time may be saved if a mortise chisel is available, for this tool is designed to stand up to blows from a wooden mallet, when it will remove the waste quite rapidly. If the joint is well cut, glue is quite sufficient to hold it.

The bridle joint is really an open *mortise and tenon.* If the joint is to be made in the form of a Tee piece instead of at the end of the wood, a tenon is cut on the one piece as with the bridle joint, and the socket, or mortise, is marked out on the other. Since this is no longer at the end of the wood, the sides of the mortise cannot be cut with a saw; the entire waste must be taken out by the use of chisels and perhaps dowel bits. A line of holes may be made near to one another in the waste wood with a dowel bit which is almost as wide as the mortise. The sides are then cleaned up with a "firmer" chisel, and the ends with a mortise chisel.

Fixing of uprights.—A good way to obtain a rigid fixture is to notch the baseboard, as shown in Fig. 47 A, to house the upright. The sides of the notch are cut with a tenon saw and the waste wood removed with a chisel so that the upright may be glued firmly in position and held, to give additional strength, with a screw passing freely through a countersunk hole in the centre of the housed portion of the upright, to grip into the baseboard.

Further rigidity is provided by cutting a *dovetail* in the end of the upright as in Fig. 47 B, and housing it in a notch in the baseboard, cut to the required shape. The notch could be marked out by using the dovetail as a pattern. The shoulders resting on the baseboard prevent movement from side to side. Secure the joint with glue.

Brackets.—When another board has to be erected at a right angle to a baseboard it may be necessary to support it with a bracket to make it rigid. Cut a piece of wood to the shape of *a* in Fig. 48, and see that it fits snugly into position. It may be secured

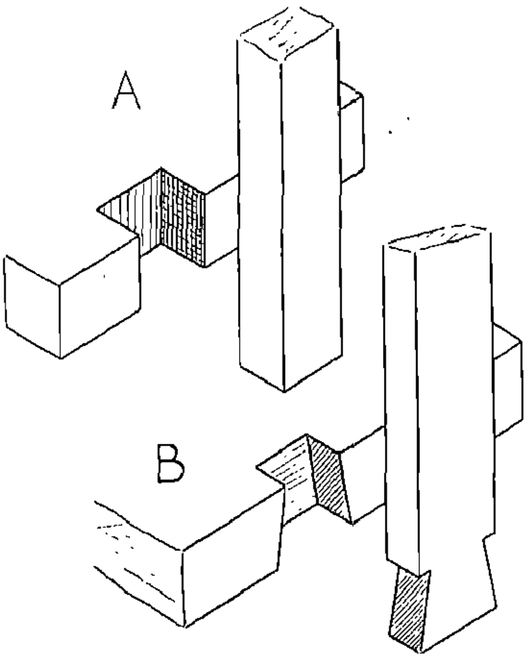

FIG. 47. FIXING A WOODEN UPRIGHT
A. Notched baseboard. B. Dovetailed upright.

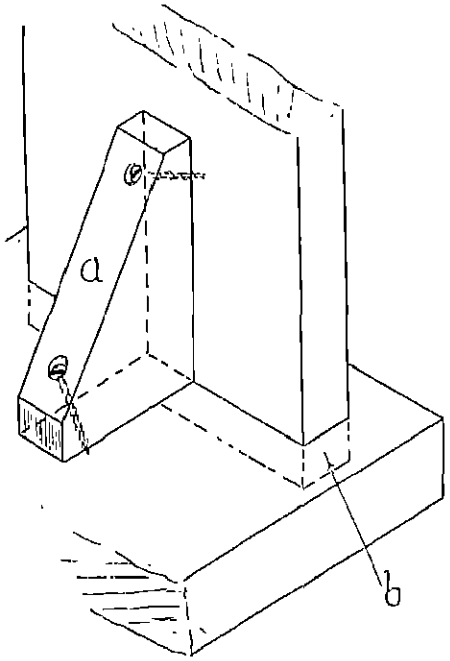

FIG. 48. A WOODEN BRACKET
a. Shaped piece of wood for support.
b. Upright glued in channel to baseboard.

with screws passing freely through countersunk holes, as shown, to grip the baseboard and the upright, or the screws may be driven from the face of the upright and from the underside of the base to grip the bracket. The choice depends largely on convenience and appearance. In either case, with only the two point fixing as shown in the diagram, some step must be taken to secure the bottom of the upright. A sound method is to cut a channel in the baseboard, about ½ in. deep, to take the upright which is glued into it as at *b*, (Fig. 48) though for most purposes an adequate fixing will be provided by passing two or three screws up through the base into the end of the upright which then may stand flush on the base without being inset. Although the screws are being put into end grain, a strong joint may be made, in this case, so long as the screws penetrate at least ½ in. In the making of all joints, care should be taken not to remove too much wood at the first cut, and to cut on the waste side of the marked lines. Tightness of fit can be rectified easily by paring away a little of the excess wood with a chisel or plane, but a sloppy fit will always mean a weak joint.

Bearings.—Several types of bearing are shown in figures 49–54, each having certain advantages and limitations. These should be considered in making a choice for any piece of apparatus according to the need for strength, ease of construction, friction losses, etc.

A very simple type consisting essentially of needle points running in centrepunch dents is shown in Fig. 49 A. If the thrust of the supports against the spindle is light, this bearing is almost frictionless and is very good for light work such as a suspension for galvanometer needles, and for the axle of the rotor in light electrical motors, Fig. 47. Sewing needles, knitting needles, and silver steel rod may all be used as spindles. The main drawback to this type is that it does not permit the taking of a drive, as the lateral tension of the pulley string will drag the points out of their sockets.

Fig. 49 B is a modification of Fig. 49 A, to allow a light drive to be taken, and retains the needle point which is prevented from slipping by the plain bearing incorporated as in the sketch. If the metal is bent twice over a former and drilled at *c* (Fig. 49 B) to accommodate the spindle, the point can be left to make contact with the other part of the support at *b*, Fig. 49 B. No centrepunch dent is needed in this case.

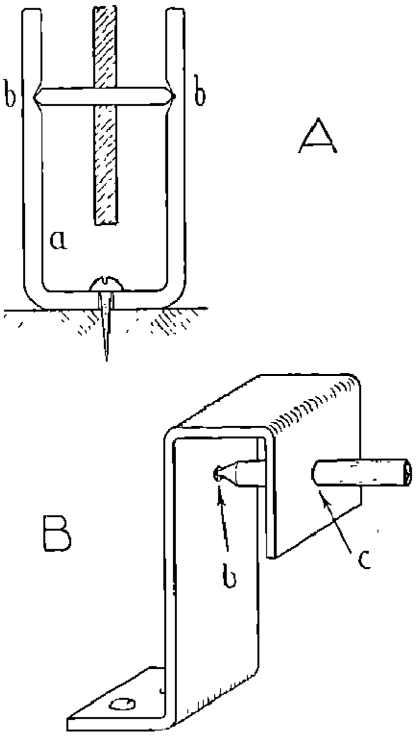

FIG. 49. TWO NEEDLE-POINT BEARINGS
A. *a*, Bent brass strip,
b. Centrepunch dents.
B. The plain bearing at *c* gives lateral strength.

A further modification of the same principle shown in Fig. 50, with stouter materials, will be found useful for such apparatus as Morse keys, sounders, dip needles, etc. The supports are of brass strip about ⅝ in. wide by ⅛ in., or even thicker, drilled to take the fixing screws and bent to a right angle. Annealing will probably be needed. The two supports are then fixed in a vice, back to back with their bases level, and drilled with

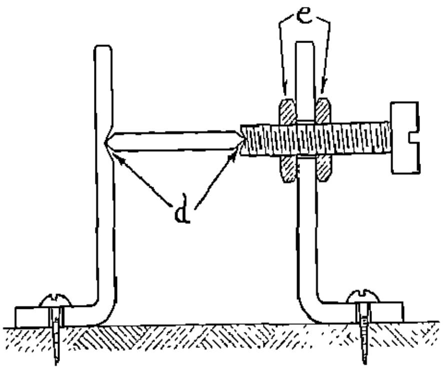

FIG. 50. AN ADJUSTABLE NEEDLE BEARING
d. Depressions made with a drill.
e. Locknuts.

a clearing drill to penetrate one and to form a substantial depression in the other, Fig. 50 *d*. A similar depression is drilled in the end of a bolt which is held in position by two locknuts at *e*, Fig. 50. As alternatives, the hole might be drilled with a tapping drill and tapped to take the bolt and one locknut, or one of the nuts might be sweated into position on the face of the support at *e*, Fig. 50. If the metal is thick enough to take a thread, the first of these two alternatives is probably the best method of securing the bolt. It leaves only one nut loose for adjustment.

Sometimes one wants to dispense with a locknut, and yet have a screw which will keep its adjustment. In this case, when the support is thick enough to allow it, a 2 B.A. tapping hole is drilled for the screw (Fig. 51 *f*) and one of 4 B.A. size at *h* (Fig. 51) above it and at a right angle to it. A sawcut at *g* (Fig. 51) is taken through to the larger hole, which is then tapped to take the screw, Fig. 51 *f*. The other screw, *h* (Fig. 51) is intended to close the gap (Fig. 51 *g*) if required, therefore a clearing drill must be put through the hole as far as the gap, and the remainder of the hole, on the other side, tapped for 4 B.A. The smaller screw may often be dispensed with, the tightening being achieved by closing the gap slightly with light hammer blows, or by forcing it closed in a vice.

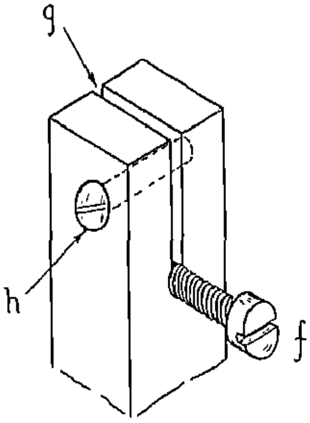

FIG. 51. A METHOD OF TIGHTENING A SCREW
The screw (*f*) is held by tightening the smaller screw (*h*), thus closing the gap (*g*).

Figs. 52 A and B are examples of plain bearings, which can give very efficient service if kept lubricated. They have the advantage of lateral strength and are particularly suited for operating a pulley drive. The wearing quality will depend largely on the depth of contact provided in the bearing.

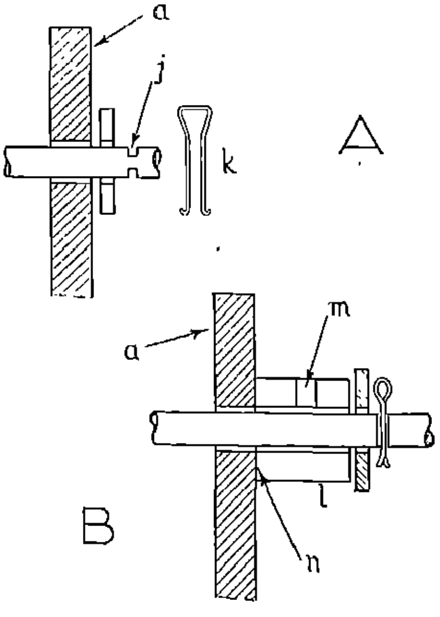

FIG. 52. PLAIN BEARINGS
A. *a*. Support.
j. Shallow hacksaw slots.
k. Spring clip.
B. *l*. Round brass rod.
m. Oil hole.
n. Bush sweated on.

Fig. 52 A shows a plain hole drilled in the support, *a*, the shaft being held in position by a spring clip, *k*, shaped without heat treatment from a length of steel wire. It beds down into two shallow hacksaw slots at *j*, a washer preventing contact between the support and the clip. This is quite a simple and effective method of fixing the shaft. Two modifications are shown in Fig. 52 B. A short length of round brass rod sweated to the face of the support before drilling increases the effective thickness of the metal at this point, and thus prolongs the life of the bearing. It also allows for the provision of an oil duct. In this diagram the shaft is shown to be drilled to take the split pin in place of the spring clip. This is more positive than the spring, which may become dislodged; but that should seldom occur.

So far we have two methods of securing the shaft against movement along its axis—the spring clip and the split pin. Adjustment along the axis is possible with these methods only by packing with washers of various thicknesses. Where wider adjustment is advisable we may use a collar, which is a section of brass rod filed flat at the two ends and drilled for the axle and for a setscrew, Fig. 53, *p*. The setscrew beds down on a part of the axle which has been filed flat, or it may bed in a depression made by a drill, if adjustment along the axis is unnecessary. This method may also be used for fitting a flywheel, a cam operating an electrical contact, etc. A further stop is available by the use of locknuts (Fig. 53 *q*), one nut being tightened up on the other.

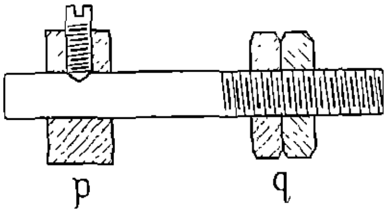

FIG. 53. TWO LOCKING DEVICES

p. Collar and setscrew.
q. Locknuts.

Fig. 54 shows a simple thrust bearing capable of taking a heavy load. It is very efficient. A hole is drilled in the shaft, *s*, to take a ball-bearing which may either be a driven fit or be held in position with a spot of liquid cement. The other bearing surface is a hardened steel rod, *r*, just an easy fit in the hole. This is ground off quite flat and sweated into position in the bedplate.

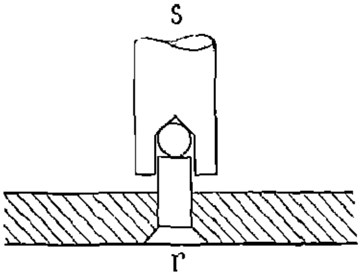

FIG. 54. A THRUST BEARING

r. Hardened steel rod.
s. Shaft.

All bearings should be lubricated with machine oil or some similar light lubricant.

It is sometimes advisable to have a metal bearing in a wooden structure as, for example, in an oscillating beam. This can be provided by screwing two drilled face-plates to the beam as in Fig. 55, making an oversize hole in the wood so that it does not touch the axle.

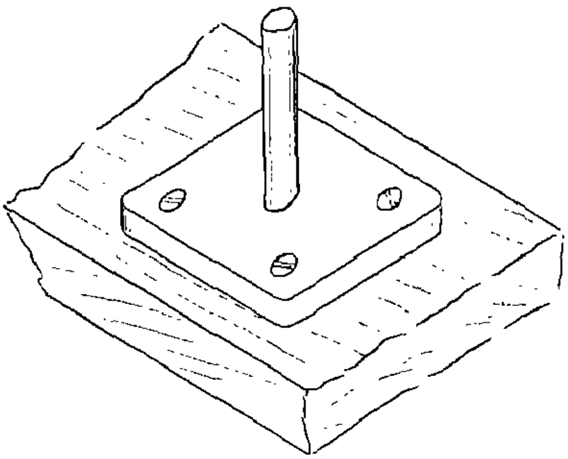

FIG. 55. A FACE PLATE

An alternative method is to make a hole in the wood to take a short length of drilled brass rod, which is fixed with liquid cement, to serve as a bush.

Cranks.—These are required in model construction whenever a reciprocating movement is to be linked up with a rotary one. The eccentric movement is but a modified crank. Some of the simpler methods of construction are given below, and illustrated in Fig. 56.

When the axle is of mild steel or soft iron it may be bent cold in a vice to form the simple crank shown in Fig. 56 A. The connecting rod may be prevented from slipping off the crank by one of the methods already given in the section dealing with bearings. Steel axles may be treated in the same way if well annealed, or if the bending is done at red heat either by holding them with pliers and hammering them over the horn of a small anvil, or by lining the jaws of a vice with slips of asbestos sheeting before bending them over the vice jaws as described *in the section on the bending of metal.*

Fig. 56 B is an alternative to A. The crank may be built up to save the space lost at each of the bends, which may be considerable with shafts of greater diameter than $\frac{1}{8}$ in. Two holes are drilled in a brass plate to take the shaft and bearing spindle, which are tinned and sweated into position.

When the crank is required at some point on the shaft other than an end, a double form is employed, Fig. 56 C. This is built up as before, using two drilled plates. To avoid difficulty in getting a correct alignment in the two parts of the main shaft, it is passed right through the two plates while the bearing spindle is passed through the other two holes. Both rods are tinned and sweated into their holes and then the short length of shaft between the plates is cut out with a hacksaw. Any portions of rod then protruding are filed away. One difficulty with this type of crank is that the end bearing of the connecting rod must be built up (Fig. 57) since it cannot just be slipped on the spindle as it is when the crank is at the end of the shaft.

A suggested method of making this end bearing is as follows:—

For a $\frac{3}{16}$ in. spindle take a $\frac{3}{4}$ in. length of brass bar, $\frac{5}{8}$ in. by $\frac{1}{4}$ in. cross section. With very careful working, $\frac{1}{2}$ in. by $\frac{1}{4}$ in. would do. In one end drill a hole to take the connecting rod to a depth of about $\frac{1}{4}$ in., Fig. 57 *a*. With a hacksaw cut across the metal at *d* (Fig. 57), true up the face of the cut, sweat the two parts together, and through the $\frac{1}{4}$ in. dimension drill another hole in the

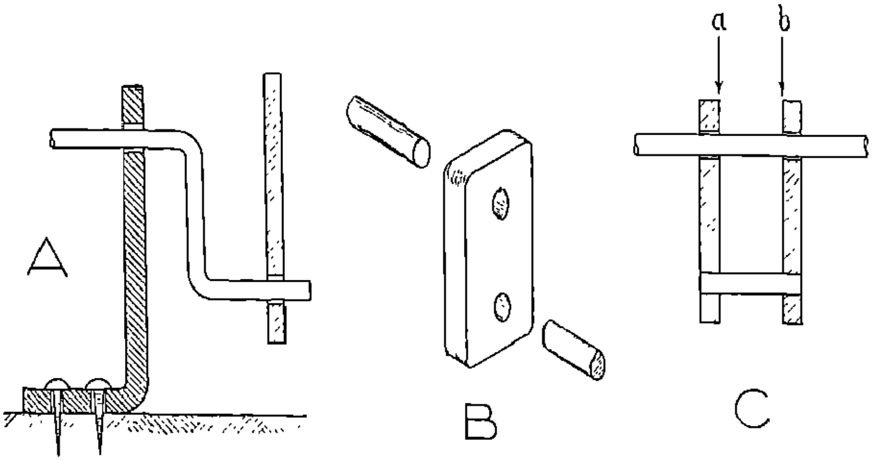

FIG. 56. CONSTRUCTION OF CRANKS

A. A simple bent rod. B and C. Built-up cranks.
a–b. Part of shaft to be cut away.

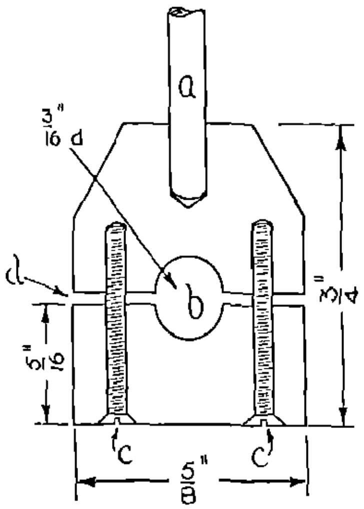

Fig. 57. An End Bearing

a. End of connecting rod.
b. Hole to take spindle.
c. Adjusting screws.
d. Metal cut by hacksaw through the centre.

face of the bar to accommodate the $\frac{3}{16}$ in. spindle (Fig. 57 *b*). With a 6 B.A. tapping drill make two holes in the other end of the bar (Fig. 57 *c*, *c*) and countersink them. Separate the two parts by gentle heating. Now put a 6 B.A. clearing drill through the two countersunk holes in the small part of the metal, and tap the continuation of the holes 6 B.A. The parts may then be assembled on the crank.

The eccentric assembly, shown in Fig. 58, is particularly useful in the construction of plywood working models such as internal combustion engines, steam engines, etc. Glue and brad a disc of 6 mm. plywood, (Fig. 58 B, *a*), at the correct eccentricity, to the face of, say, a flywheel (Fig 58 B, *b*) and cut out the connecting rod (Fig. 58 B, *c*) of 5 mm. plywood, the other 1 mm. of thickness serving as a clearance. File and glasspaper the hole to give a free yet uniform fit, and place the connecting rod in position.

Cover the bearing with a disc of thin plywood (Fig. 58 B, *d*) about 2 mm. thick and sufficiently larger than the disc, *a* (Fig. 58 B), to act as a retaining piece. Glue and brad it into position. If this bearing is lubricated with french chalk it is quite efficient.

The same construction can be usefully used for other bearings in plywood models

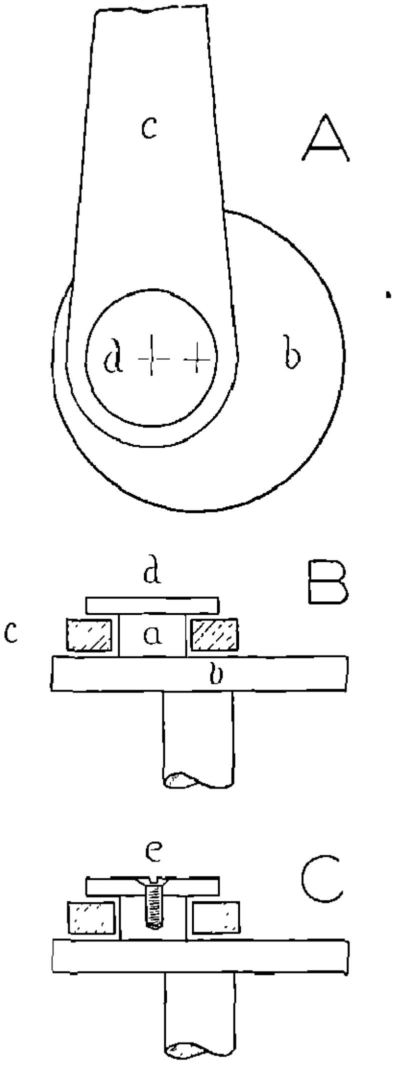

Fig. 58. Eccentric Bearings

A. Plan.
B. Sectioned elevation, made in plywood.
C. The same bearing, made in metal.
a. Plywood disc.
b. Flywheel.
c. Connecting rod.
d. Disc covering bearing.
e. Screw.

in addition to eccentrics; e.g., valve rockers, little and big ends, crossheads, etc. . . .

Fig. 58 C shows a similar construction in metal. A disc cut from say $\frac{5}{8}$ in. round brass rod is sweated to the face of the wheel, drilled and tapped so that a sheet brass cover plate may be screwed into position to retain the connecting rod.

Flexible transmissions.—The two methods dealt with here are chosen for their simplicity of construction and effectiveness in use.

They will be found to serve most, if not all, the purposes required in ordinary science handicraft, though others may be needed for model engineering. The first (Fig. 59 A) involves the use of a length of window-curtain spring, obtainable at most ironmongers and "sixpenny" stores. With the shaft in a vice, and using the safe edge of a file against the jaws, file a round tenon (Fig. 59 A, *a* and *b*) on the end of each part of the shaft, of the right size for a force fit into the spring. Solder run in at each junction secures the spring to the halves of the shaft. Apart from its ease of construction, this transmission has the further advantage that the spring acts as a shock absorber giving a smooth power output. If the spring is short it can take quite a powerful drive, and will function at a large angle of deviation.

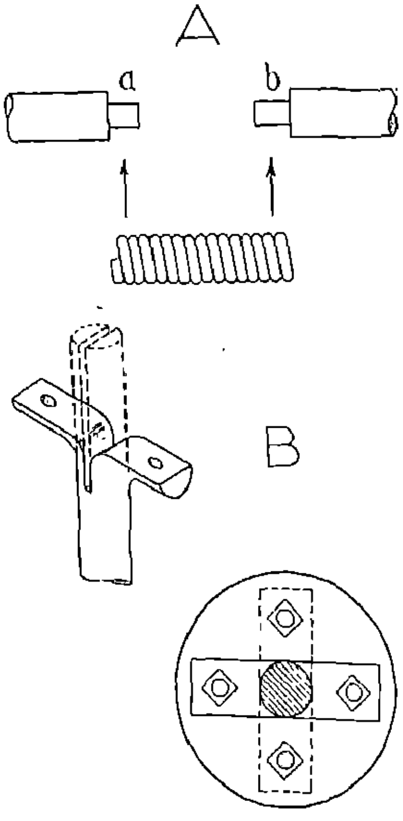

FIG. 59. FLEXIBLE TRANSMISSIONS

A. Using a spring. *a*, *b*. Round tenons.
B. Using a leather disc.

The second (Fig. 59 B) is made from two lengths of shafting, each of which is cut along its axis for a length of about $\frac{1}{2}$ in. After annealing, each half of the split end is bent outwards at a right angle, the two faces filed flat, and drilled with a small clearing drill. A disc, about 1 in. diameter, is cut from thin leather,—a piece of cowhide or the upper of an old boot,—and pierced with four holes. Small bolts are passed through the split ends and the leather and fixed with nuts, so that the shafts lie on either side of the leather with the splayed ends at a right angle to one another. This gives a very smooth transmission with an angle of deviation up to about 30°, and is capable of taking a heavy drive.

Making a bobbin.—While the coils in many electrical models may be wound directly on to the soft iron core of the electromagnet (Fig. 60) both the appearance and ease of winding are improved if the wire is wound on to a bobbin. These are frequently found in commercial articles

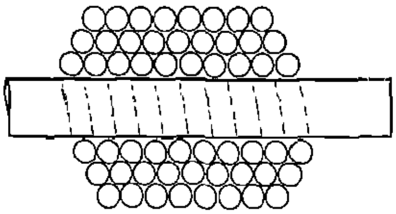

FIG. 60. WINDING A COIL WITHOUT A BOBBIN

The turns should be laid closely together, and the number of turns decreased in successive layers.

turned up from a wooden rod in a lathe, but a serviceable bobbin may be made in the following way without the use of a lathe, Fig. 61.

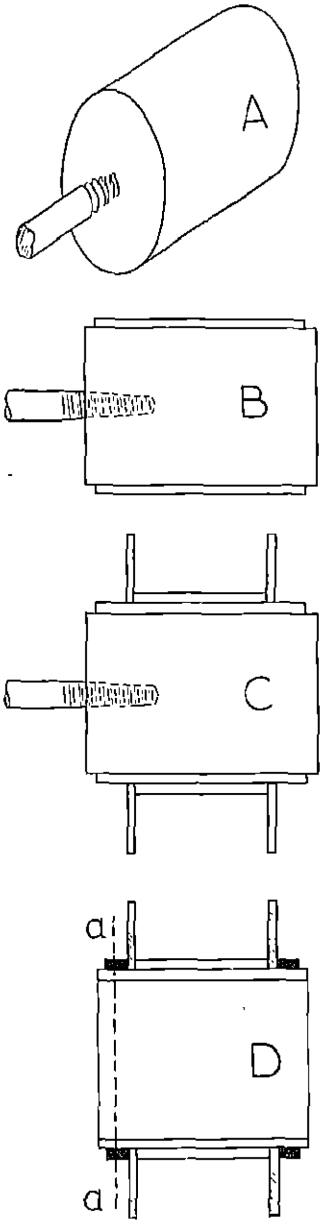

FIG. 61. MAKING A BOBBIN

A. Wooden formers.
B. Cylinder.
C. Punched cards fixed.
D. *a–a.* Excess cut away on central tube.

First make a former on which to construct the bobbin and to carry out the subsequent wiring. This may be a piece of the actual iron rod forming the core of the magnet, filed to a tenon at one end if necessary to fit into the chuck of a wheelbrace, or a piece of wood which may have any shape of cross section—round, square, rectangular, elliptical—according to the need of the situation. Its generality is one of the advantages of this method of construction.

At the centre of one end of the wooden former, a wood screw is driven in and its head removed with a hacksaw. This is to fit into the chuck of a wheel brace. Fix the brace horizontally in a vice, with the chuck pointing to the left hand side. Take care not to put too much pressure on the frame of the brace as this is usually made of cast iron *and is therefore rather brittle*, yet be sure that it is firmly fixed. Facings of cork from old table mats, or slats of soft wood between the jaws and the frame of the brace, are useful safety measures. Now fix the former in the chuck and by rotating it see that it is centrally mounted. This is of importance later, when the winding is to be done.

Assuming that one is making a circular bobbin of 1 in. aperture and with 1 in. breadth of winding, cut a few lengths of absorbent duplicating paper, $1\frac{5}{8}$ in. wide, with a knife and steel rule, and paste it thoroughly with office paste—not glue. Smear vaseline lightly all over the former and then wind on to it several layers of the pasted paper, pasted side outward, to build up a cylinder about $\frac{1}{10}$ in. thick, Fig. 61 B.

Next punch or cut some holes in a sheet of strawboard about the outside size of the paper cylinder, and cut it into pieces for bobbin ends. Test them for fit, screwing the paper cylinder through the hole by rotating it while applying one of the punched cards lightly to the end of the cylinder. The fit can be adjusted by adding more or removing a little of the pasted paper. When fitted, push one card along to the end by the chuck. Cut some more paper strips, this time exactly an inch in width, and build up a further $\frac{1}{16}$ in. or so as a central distance piece. Fix a punched card at each end, butting evenly against this distance piece, Fig. 61 C. Then cut some more strips $\frac{1}{4}$ in. wide and apply them, after pasting, outside the cardboard to retain the latter in position. Place the partly completed bobbin in an oven at about 80° to dry thoroughly before proceeding further. When hard and dry, mount the bobbin again in the chuck, and as it is rotated hold a pencil against each end to mark out circles. Trim the cardboard to the marked lines to make the discs, and with a razor blade or very sharp knife cut away any excess on the central tube (Fig. 61 D, *a–a*) to leave $\frac{1}{8}$ in. of the shoulder outside each disc. Give the bobbin several coats of shellac solution to strengthen and to insulate the paper and the cardboard, ensuring that each coat is dry before the application of the next. The drying of the shellac may be accelerated by using an oven at about 60°C.

Winding the coil.—Make a small hole through one disc of the bobbin, as near the centre as possible, and pass about 12 in. of wire through it from the inside. Make this wire fast round the chuck to prevent the bobbin from turning on the former. Holding the wire in the left hand and turning the handle of the brace clockwise with the right, feed the wire on to the bobbin to lay the turns firmly side by side. A little practice will allow the coils to be wound rapidly and neatly. When using cotton covered wire give a liberal coating of shellac after every two layers. This helps to show up the new wire, and often prevents uncoiling if the tension should be released during winding. It also binds and insulates the coil when completed. When the later layers of wire have become uneven, as sometimes happens, a neat finish may be obtained by cutting from a postcard a strip just wide enough to span the coil, wrapping it round the untidy coil and winding the final layer on the card foundation. Finish off the last layer by passing the wire of the last turn back under the last but one, thus making a half hitch, to prevent uncoiling, and give the whole a coat of shellac or other insulating varnish. Bobbins of this structure may be used in electric motors, galvanometers, transformers, etc., Figs. 7, 63, 68.

For making the hole in the strawboard for circular bobbins up to about $\frac{1}{2}$ in. diameter, corkborers will be found satisfactory, but a cleaner hole is obtained if a punch is used. Get some iron tubing (Fig. 62) of various sizes, cut pieces about 3 in. long, and file one end to give a sharp edge, finishing it smooth by grinding if necessary. Lay the strawboard on a block of hard wood, tapping the punch smartly with a hammer to make the hole. A set of such home made punches is often useful.

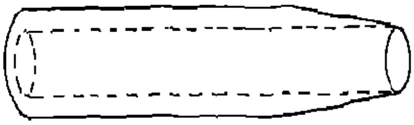

FIG. 62. A PUNCH MADE FROM METAL TUBE

Fig. 63 shows the use of a bobbin held down by brass clips, *a*, as the foundation of a galvanometer. The needle, together with an axle, pointer and balance weight, pass through a piece of cork, *c* (Fig. 63) which is then suspended between centrepunch dents, as at *b*, Fig. 63.

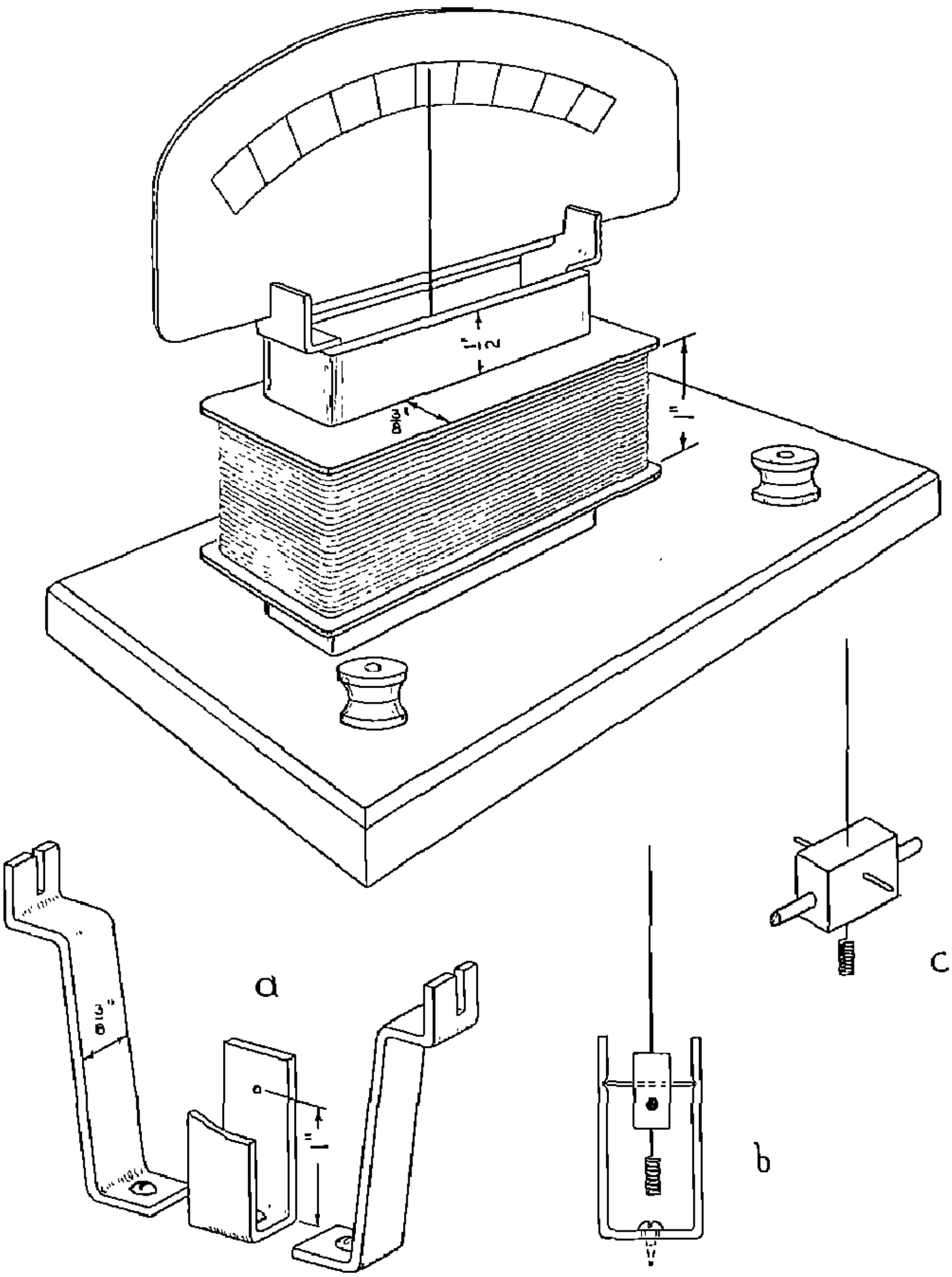

Fig. 63. A Galvanometer, Incorporating a Bobbin

a. Bobbin held down by brass clips.
b. Cork suspended between centrepunch dents.
c. Needle, axle, pointer and balance weight passing through piece of cork.

MATERIALS

Swedish soft iron.—This metal is easily worked, requiring a lubricant while being drilled or tapped. It readily forms a temporary magnet by induction and is a moderate electrical conductor.

Sheet.—16 g. may be used for field magnets and armatures.

Round rod.—$\frac{3}{16}$ in. and $\frac{1}{4}$ in. are useful for cores of horseshoe magnets; wire nails may be used when smaller sections are required.

Wire.—16 g. iron wire cut to length and bundled is used as the core of induction coils and shocking coils.

Steel.—It is more difficult to work this metal, being hard and rather brittle, though it can be forged at red heat, and in the smaller sections may be worked cold after annealing. When hard, it may be shaped and finished by grinding on an emery wheel. It may be magnetised by induction, differing from soft iron in that the magnetism is retained to a large degree.

Clocksprings.—Are used for making leaf springs and magnetic compass needles (see *Heat treatment*).

Round rod.—$\frac{1}{8}$ in. and $\frac{5}{32}$ in. silver steel rods, supplied in 13 in. lengths are useful for shafts, scribers, and small permanent magnets. Knitting needles may be used for smaller sizes than those mentioned above.

Wire.—24, 28, and 32 g. steel wire should be available for making coil springs by winding cold on to a former in a wheelbrace (see the paragraph on making a spring).

Tinplate.—Resists corrosion while the coating of tin is unbroken, therefore when marking out use a pencil instead of a scriber. For complete protection against corrosion, the cut edges should be coated lightly with solder. Being very easy to work and easily soldered, tinplate is useful for light constructional work It has a soft iron base capable of magnetisation and can therefore be employed for making laminated field magnets as in Fig. 64. In all probability an abundant source of tinplate will be found in biscuit boxes, canisters, etc.

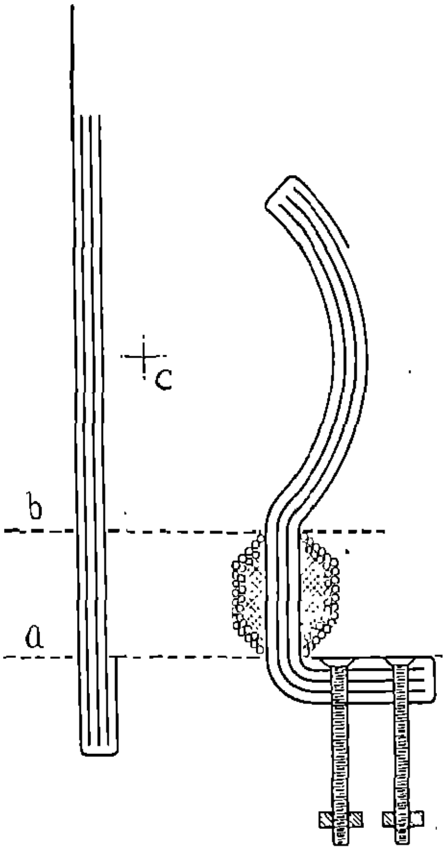

FIG. 64. A LAMINATED FIELD CORE, MADE OF TINPLATE

a, *b*. Position of bends.
c. Centre of the arc, and position of the axle.

Brass.—This has good working qualities and can easily be soldered. It may be hardened by hammering. It is a valuable material for constructional purposes, particularly in the case of electrical apparatus, since it is non-magnetic and an excellent electrical conductor. Brass is a good thermal conductor also. There is no need for a lubricant during any of the normal working processes.

Sheet.—18, 22, 24, and 26 g., obtained in sheets 4 ft. by 2 ft., are useful sizes for general construction work; they can be cut with shears, and bent cold without appreciable weakening. 26 g. sheet, hammered out on a smooth anvil, serves very well for spring contact brushes.

Round rod.—$\frac{3}{8}$ in. diameter rod is frequently of use for making bushes, collars, pillars, etc. Other sizes for general work, and to take convenient threads, are $\frac{1}{4}$ in. for 0 B.A.; $\frac{3}{16}$ in. for 2 B.A.; $\frac{5}{32}$ in. for 4 B.A.

Bar.—$\frac{1}{2}$ in. by $\frac{3}{8}$ in., and $\frac{3}{8}$ in. by $\frac{1}{4}$ in. will be found useful for pillars and for the bosses of clamps, etc.

Tube.—$\frac{5}{8}$ in. and $\frac{1}{2}$ in. outside diameter tube, with a wall thickness of 18 to 20 g., can be used for making commutators. $\frac{1}{4}$ in. tube is sometimes handy for use as distance pieces.

Strip.—$\frac{1}{2}$ in by $\frac{1}{8}$ in. finds a place in construction work to serve as a support for a bearing and to answer the occasional need for a material which is stronger than the 16 g. sheet. It will generally need to be annealed before being bent to a right angle.

Copper.—This is rather too soft for constructional work, though it may be hardened by hammering. Its working qualities are similar to those of a soft brass. It also is an excellent electrical and thermal conductor, and is non-magnetic.

Sheet.—Is seldom needed, though the 24 g. will sometimes be found useful.

Tube.—In $\frac{1}{4}$ in. and $\frac{1}{8}$ in. diameter sizes copper tube may be used in the making of steam jets (Figs. 3 and 4), and convection apparatus. In the annealed condition these small sections may be bent easily, though care must be taken to avoid kinking. One may guard against this by filling the tube, prior to bending, with melted resin or with closely packed, fine silversand.

Gauze.—Two layers of fine copper gauze wrapped round a brass strip where it touches the commutator ensures a smooth and continuous electrical contact. It is secured at the back with a touch of solder.

Wire.—The gauges most commonly used in the construction of electrical models in schools are 24 and 26. Heavier gauges are hardly ever called for except in the construction of transformers, and the lighter gauges are not very easy to wind when making an electromagnet. Double cotton covered wire will answer most purposes, particularly if it is given an insulating coat of shellac varnish. It is sometimes possible to obtain supplies of wire from cheap disposal stores, much of it being enamelled. This will be found quite suitable for general purposes, the enamel being a very efficient insulator so long as it is undamaged. It is sufficiently flexible to stand reasonable bending without failure. One disadvantage of enamelled wire is its tendency to become unwound from the bobbin if the tension is released. The last turn should therefore be adequately

COPPER WIRE DATA

The figures quoted below are intended as close approximations and should be regarded as such.

Standard wire gauge	16	17	18	24	26	28	32
Diameter of bare wire	·064 in.	·056 in.	·048 in.	·022 in.	·018 in.	·015 in.	·011 in.
Yards per pound	27	35	48	230	340	500	950
Turns per inch	13	15	17	32	36	40	50
Safe current, single wire, amps.	15	12	9	3	2	1·5	1·0
Safe current, close coil amps.	6	4·5	3·5	·75	·50	·30	·15
Resistance, ohms/yard	·0075	·001	·013	·063	·095	·140	·270

secured. An overall coat of varnish binds the coil when it is dry.

Standard wire gauge.—To convert S.W.G. sizes to approximate fractions of an inch remember that 16 S.W.G. is equivalent to $\frac{1}{16}$ in. For every 6 numbers above or below 16 g. the thickness is halved or doubled.

S.W.G. .	10 g.	16 g.	22 g.	28 g.
Diam. . .	$\frac{1}{8}$ in.	$\frac{1}{16}$ in.	$\frac{1}{32}$ in.	$\frac{1}{64}$ in.

Zinc.—Is sometimes used for light construction work. It is fairly easily corroded by acid and alkaline solutions, but resists corrosion by the atmosphere and fresh or aquarium water. It should be worked at about 50°C. since it is brittle at room temperatures, tending to crack along the line of a bend. It is easily soldered, using 10% hydrochloric acid as a flux. Thin sheet zinc is used in making dry primary cells. When ordering, remember that the thickness is measured by a zinc gauge, not S.W.G.

No. 4 Zinc gauge = 34 S.W.G.
No. 8 ,, ,, = 28 ,,
No. 14 ,, ,, = 21 ,,

Lead.—Collect scrap lead and composition tube for casting flywheels, vice clamps, accumulator plates (for demonstration of the method of plate forming only), etc.

Silver solder.—22 g. wire, bought by the ounce, will be found useful as a substitute for platinum in the making of electrical contacts.

Tinsel.—The thin metal braid is handy for light flexible electrical connections such as the strip suspension in a moving coil galvanometer.

Timbers.

Oak.—Has a very good appearance and is useful for framework and baseboards. It is hard and is inclined to split when used in thin sections. The working qualities are generally good, so long as the tools are kept sharp, but occasionally one finds a board which is difficult owing to a great diversity in the direction of the grain.

Mahogany.—This includes the African "mahoganies." These timbers are excellent for baseboards, having a pleasant appearance and being capable of taking a fine finish. They are fairly soft and easily worked.

Whitewood, American or Nigerian.—These are fairly strong and light, and may be recommended for both baseboards and framework when expense prevents the use of the two previous timbers. Whitewoods are usually easy to work, having a smooth texture and a grain which is not pronounced, but occasionally one meets a sample which is very hard. They have no great tendency to split.

Deal.—This includes the many varieties of softwood available. These timbers are characterised by their pronounced grain, which makes them strong in the direction of the grain but liable to split along the line of the spring wood. When straight grained and free from knots, they are very useful for framework construction, but one cannot recommend them for baseboards since they do not lend themselves to clean workmanship and good finish. One merit is that they are cheap.

Balsa.—This is a very soft wood indeed, whose place in this list is due to its being the lightest timber obtainable. It is useful, therefore, in model aeroplane construction and the making of very light moving parts such as pointers, etc. It is worked by cutting with safety razor blades mounted singly, or in pairs for parallel cuts, in wooden handles, after which it requires no further treatment than a possible light glasspapering. It can be obtained in many convenient sizes from those shops which cater for model making and similar hobbies.

Plywood.—This is a valuable material for use in construction, and is obtained in a variety of thicknesses which are measured in millimetres, 4 mm., 5 mm., and 6 mm. threeply are most generally useful. Working diagrams of mechanisms are easily made if a variety of thicknesses is at hand to give the necessary clearances between the moving parts. Such models are lubricated with French chalk.

Note on wood finishing.—Having planed the surface of a piece of wood and smoothed it down with glasspaper, one is ready to give it a permanent finish. This may first involve a staining process, but whether stained or not, the wood will need to be given a polish, either with wax or French polish, both to improve its appearance and to prevent it from getting dirty.

Staining.—Water stains, being cheap, efficient and easily applied, will generally meet the demands of science handicraft. Their one demerit is that they tend to raise the grain of the timber, but this may be overcome by giving the wood a preliminary treatment with cold water, thus raising the grain before staining. When dry, the somewhat roughened surface is rubbed down with glasspaper; the further wetting when the stain is applied raises the grain so little more, that only the lightest of glasspapering is needed to restore the surface. To apply the stain, take some of the liquid up on a pad of soft rag and rub it lightly into the wood with a spiral or figure of eight movement, covering the entire surface several times. Take care not to allow any part to dry out during the process, and avoid excess of stain which may form streams running on to some other part of the work, or which may lie on the surface in pools giving a patchy appearance when dry.

Walnut "crystals".—Dissolved in water with the addition of a little ammonia, these form a brown stain which can be used with all the timbers mentioned above, but it gives rather a "muddy" finish to whitewood.

Potassium dichromate solution.—This gives a warm brown colour to oak, and a rich reddish brown to mahogany. When it is dry, remove the bloom which forms on the surface by a light rubbing with fine glasspaper before polishing.

Potassium permanganate solution.—This is frequently used with deals and pines,—the softwoods,—to give a pleasant, lasting brown colour. It should not be used with oak, mahogany, or any other hardwood.

Creosote.—When diluted with turpentine to give the required depth of colour, this has been found to give satisfactory results with most timbers and over a fair range of shades. It is applied sparingly with a brush or rag. Leave the wood for a day or so to allow the creosote to be absorbed, then cover the stained surface with a coat of french polish applied in steady continuous strokes with a soft brush. When thoroughly dry, the shellac surface produced may be rubbed down with very fine glasspaper and finished by French polishing. Wax polish is not satisfactory with creosote solution.

Polishing.

Wax polish.—Prepared as described below, is applied evenly to the surface both along and across the grain, and finished by rubbing vigorously with a coarse cloth. It gives a dull gloss, and affords a durable protection, against dirt. When the gloss is lost it may be restored by further rubbing. Applied directly to unstained oak it gives a very satisfactory finish. Wax polish gives a slightly opaque appearance to the surface.

French polish.—This is prepared as described below. An adequate, though not professional, finish is obtained by giving the wood three coats of French polish with a soft brush, leaving each coat to harden and lightly glasspapering it with fine glasspaper before proceeding with the next coat. The polish should be applied smoothly, with steady strokes, without the formation of bubbles. This may give a satisfactory surface without further treatment, but it will be improved by finishing with a pad or "rubber." In the centre of a six inch square of old linen place a wad of cotton wool shaped to form a shallow cup, and into the cup pour some French polish. Fold the linen back over the cotton wool to form a pad, rather pointed at the toe and rounded at the heel where most of the spare linen is gathered. Grip this linen with the third and fourth fingers, place the first finger nearer to the toe of the pad and work the polish through from the cotton wool to the lower face of the linen. If this pad is rubbed lightly over the surface to be polished, with spiral or figure of eight strokes, a surface is gradually built up. The rubber is kept moist by the addition of more polish to the cotton wool inside. After a little while the rubber tends to run less easily. This may be due to its becoming too dry, but if not it is a danger sign, and the rubbing should be discontinued for a short while, otherwise the surface already built up may be damaged (pulled). The final polish is given with long sweeping strokes up and down in one direction, the smooth movement being accompanied by a light pressure. A trace of olive oil, applied from the tip of a finger, reduces the tendency to pull the surface in the later stages. Considerable practice is needed to obtain a really good finish with a rubber. When not in immediate use, the rubbers should be kept in a tin box to prevent them from hardening.

Miscellaneous materials.

Bakelite and ebonite.—These are good electrical insulators useful for making handles for electrical apparatus. They take a screw thread fairly well. For general use, $\frac{1}{4}$ in. sheet and $\frac{1}{2}$ in. round rod are convenient sizes. $\frac{1}{16}$ in. sheet may be used for making insulating washers.

Shellac, and sealing wax.—A good insulating varnish, very similar to that sold as french polish, may be made in the following way. Cover some flake shellac in a bottle with methylated or industrial spirit, and leave for two days with occasional shaking. Thin it down if necessary by adding more spirit. Coloured varnish may be made by using crushed sealing wax in place of shellac. These varnishes are useful for insulating and holding together the coils of electro-magnets, and the shellac solution is employed to give a finish to woodwork after staining.

Pitch.—This is used in a melted condition for waterproofing, as in aquarium construction, or as an insulating seal for primary cells, and embedded wires.

Paraffin wax.—This is an electrical insulator, useful for soaking coils after winding by lowering them into a jar of melted wax and allowing them to drain, and for filling the grooves of embedded wiring. Ironed into unglazed paper, it makes a good insulating material for condenser and transformer construction.

Beeswax.—This forms the basis of wax polish as used for timber. Melt some beeswax over a sandbath in a fairly deep tin. Then, removing to a distance all naked flames, add turpentine to give the consistency of a wax polish. A little taken from the melt, after stirring, with a glass rod, cools quickly to give an idea of the cold condition of the mixture. Should the liquid catch fire, cover the tin with a sheet of metal or asbestos board without hurry; the flame is easily smothered. This will not happen, however, if flames have been removed.

Electrotyping wax.—This can be made by melting together beeswax and paraffin wax and adding a very little turpentine. It should be plastic when slightly warmed.

Plaster of paris.—This is used for taking castings in lead (see p. 420). Being hygroscopic, it should be stored in a container which can be sealed with melted paraffin wax.

Portland cement.—This must be similarly stored. Mixed with sand—about 3 measures of sand to 1 of cement—it forms a concrete useful for lining aquaria and ponds.

This list might be extended to include cellulose enamels, seccotine or other liquid glue, office paste, insulating tape and gummed linen tape, valve rubber, rubber sheet (old football bladders), olive oil, light lubricating oil, glasspaper, emery cloth, vaseline and strawboard. Other oddments will suggest themselves as they are needed. It is worth while making a collection of articles which might serve as formers and anvils; lengths of gas barrel of several sizes, sections of girders or railway metal, and an old flatiron. Many oddments of mechanisms and materials may often be found in "disposal" stores, and a number of the things sold in the "sixpenny" stores may be pressed into useful service.

SCIENCE HANDICRAFT IN THE VARIOUS BRANCHES OF SCIENCE

It is impossible, here, to give anything approaching an adequate list of models and apparatus capable of construction in schools. By far the best plan for an interested teacher to adopt is to keep his need ever in mind, noting the possibilities latent in children's toys, in the many books dealing with model making, and in some of the more modern text books and books of popular science. The compilation of a note- and sketch-book, in addition to the intrinsic interest it provides, will give the teacher a good idea of the needs of his pupils and the means through which he may employ them in teaching. Many models, after a little redesigning, are within the power of pupils with but moderate craft experience.

Here we survey, broadly, the scope offered by the several branches into which science may sometimes be divided.

Chemistry.—For the purpose of class practical work chemistry offers a limited scope, but a facility in glassworking allied to a knowledge of the working processes outlined in earlier sections, will allow a teacher to make and to keep in good repair the apparatus required for teaching the subject. A boy may take a keen interest in making his own bunsen burner, test tube rack, retort stand, filter stand, etc., and there is no reason at all why he should not do so if the desire is there, but at the same time it is clear that such items are contributing little in a direct way to the illustration and clarification of scientific principles. The home of such work is the craft room rather than the laboratory. The lack of scope for science handicraft in chemistry is of minor importance, for this branch of science is treated in most senior schools as ancillary to physics and biology, and offers plenty of opportunity for individual practical work within its own field.

Physics.—This is far more fruitful, and is at the same time nearer to a boy's understanding at the senior school stage.

General physics and mechanics.—This calls for such things as hydrometers, made from broken pipettes or other readily available materials. A wooden skewer fixed through a cotton reel, weighted below with lead strips or discs and varnished with shellac, is one example of the use of such materials. Surface tension apparatus, hygrometers operating either with degreased hair or catgut, simple balances of the spring or lever type and more easily constructed variants of the mechanics frame (Fig. 6) or of its several parts, are further examples of the possibilities of this section.

A useful model of a Pelton wheel might be included here. The one shown in Fig. 65 is housed in a tin canister, A, with one side removed, the edges of the hole being stiffened with iron strips, Fig. 65 A, *b*. Holes at *c* provide an outlet for waste water after entering through the jet (Figs. 65 C and 65 A, *d*), which is soldered into a hole in the end of the canister, and brass bushes are provided at *e* (Fig. 65 A) to increase the bearing surface. A cover plate, *f*, sprung into position acts as a splash guard. The rotor (Fig. 65 B) is built from a disc of brass or tinplate to which are soldered the buckets, *k* and *l* (Fig. 65 B), which have been shaped over a former, *m*—a slit being provided to allow them to slip on to the disc. A bush and setscrew give a means of fixing the rotor to its spindle, the latter being retained in position by two collars (Fig. 65 B, *n*) and washers, touching the inside of the canister. This method also allows for adjustment of the rotor with regard to the jet. Fitted with a small pulley, the motor can be used to drive small models.

A study of heat.—This presents the opportunity for making several kinds of expansion apparatus and examples of their application, such as fire alarms (Fig. 32) temperature regulators and recorders operated by mercury expanding in a glass tube to close a circuit, bimetallic strips and coils, expanding rods as in the gas-oven thermostat, and fusible plugs. Some of the conduction apparatus also is simple to make. A number of types of steam engine might be included. A reaction type, like Hero's engine may be made by mounting a ball from a cistern on a

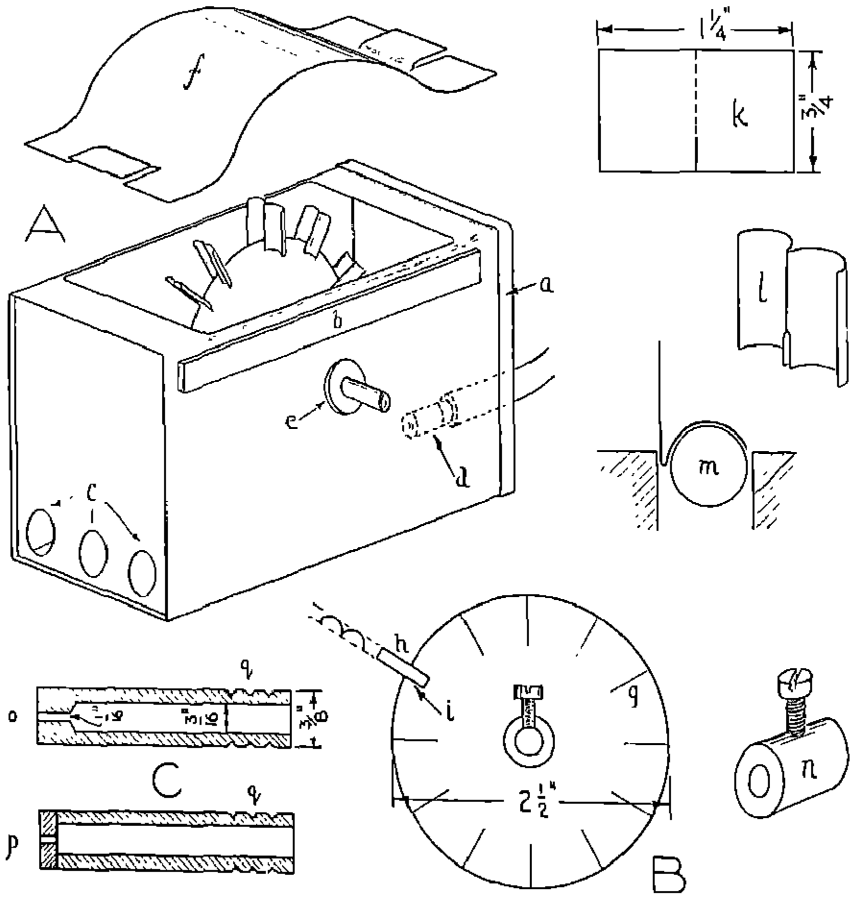

FIG. 65. A PELTON WHEEL

A. Wheel housed in tin canister. B. Rotor. C. Alternative jets.
a. Lid. *b*. Iron strip. *c*. Holes providing outlet for waste water. *d*. Jet. *e*. Brass bushes. *f*. Cover plate. *g*. Scribed lines. *h*. Bucket in position. *i*. Soldered joint. *k* and *l*. Buckets. *m*. Former. *n*. Collar. *o*. Orifice. *p*. Disc soldered and drilled. *q*. Filed depressions to grip tubing.

vertical axis, and soldering two copper tubes bent at a right angle, one at each end of a horizontal diameter as in Fig. 66.

The plug (Fig. 66, *b*) at the top, serves as both axle and filler plug. In addition to this there are the turbines shown in Figs. 3 and 4. A few boys with an aptitude for model making might make an oscillating cylinder engine like those found in many model locomotives.

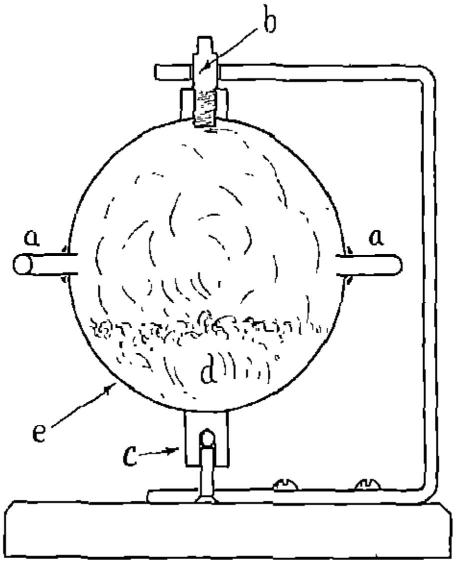

FIG. 66. HERO'S ENGINE

a. Bent copper tubes.
b. Bearing and filler plug.
c. Support on a ball bearing.
d. Water.
e. Point of application of heat.

Electricity presents by far the greatest field. In addition to electric motors, controls and measuring instruments on the lines of those already dealt with, there is the opportunity, here, for full scale construction, with the added interest which comes when dealing with the "real thing." A telephone system, a mains transformer, and the wiring of the laboratory (Fig. 67) might be undertaken as projects by a group with, of course, the necessary help of the teacher.

A transformer is described in the final chapter, capable of giving an output of between 4 and 5 amps., at 12 v. from a 230 v.–240 v. supply, and having a centre tapping to allow two parallel 6 v. circuits to be obtained. This can be used with a 48 watt car headlamp to supply the power to projection apparatus such as a lantern for slides or strip films, and a microprojector, and may be used to throw shadows of apparatus and of ripples in a shallow glass trough of water, etc., see Fig. 74. It will also enable 6 v. lamps to be used by pupils for ray projection experiments in the study of light. With individual rays differently coloured by gelatine colour filters, the path of a beam through various optical systems of lenses and mirrors can be investigated. Simple A.C. synchronous motors such as are used in electric clocks, and models of a housewiring system serve as a further link between school work and the life outside.

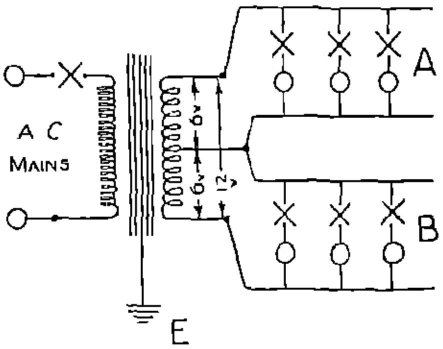

FIG. 67. DIAGRAM FOR WIRING A LABORATORY

A and B. Circuits to two benches.
E. Earth.

Biology.—In biology, as in chemistry, there is less scope for science handicraft as a class activity. Since most of the main principles are capable of illustration only by biological material, the chief application left to handicraft is in the construction of apparatus. Much of this will be concerned with the processes of glassworking, for potometers, etc., and the simple carpentry needed in making cages, vivaria, incubators, etc. The transformer and the microprojector which it operates serve a further part in the needs of biology, but evidently most of the work will have to be done by a teacher familiar with the general working processes and methods of construction. Aquaria are well worth the making, for they are expensive to buy, and several are needed when there is a biological bias to the work. One method of construction is described in the final chapter.

THE EQUIPMENT OF A ROOM FOR SCIENCE

Much of the value of science handicraft will be lost to science if a full metalwork and woodwork equipment is provided and the models made from blueprints, though these things have their legitimate place if the work is being done mainly as a craft activity and in a craft centre. We are not concerned, here, with the equipment of a craft room, but rather with those modifications to a normally fitted laboratory which will permit science handicraft to be carried on as a class activity under the direction of the science teacher. Such modifications are neither expensive nor far reaching.

Permanent fixtures and working tools.—There should be one strong bench about 6 ft. long, fitted at one end with a woodwork vice and bench stop, and at the other with a 4 in. vice for use in some of the heavier metalwork operations. It is desirable, too, that this bench should carry a bench drill accompanied by a small machine-vice, which may be home made (see Fig. 5). Granted these initial items, there will be no need for further general bench equipment beyond the provision of some 2½ in. metal vices, placed at convenient points on the existing benches or tables. Each of the smaller vices will serve the needs of two or three boys, or of a small group working together. With the main bench should be provided a full set of woodwork tools, such as are found in a normal woodwork centre, together with a rack of occasional tools,—handsaw, fretsaw, brace and a set of dowel bits and a countersink bit, two small gouges, bradawls and a screwdriver.

In most cases there should be no need for further woodwork tools beyond, say, two extra tenon saws and a few chisels, since the work does not demand that all the boys should be performing the same operation at the same time. There is sufficient variety in the work to allow a boy to get on with the marking out or construction of some other part of the model if the equipment he wants is not immediately available. Herein lies part of the training.

There is little point, too, in providing a kit of metalwork tools for each working place. A large rack should be constructed with a place for each tool which may be held in a spring clip, a looped leather strap, or a narrow wooden shelf drilled with appropriate holes. If the tools are grouped and their places labelled, e.g.,—

←——— 6 screwdrivers ———→

the checking of equipment is greatly simplified. The boys should be encouraged to return a tool to its place when they have finished using it.

A fair beginning may be made, on the basis of a working unit of 20, with the following tools for general use:—

8	5 in. flat nosed cutting pliers
2	4 in. round nosed pliers
6	ball paned hammers, 12 oz.
3	3 in. screwdrivers
3	4 in. screwdrivers
6	6 in. flat second cut files, with safe edge
6	6 in. half round files, second cut
2	4 in. three cornered files
6	assorted ward files
8	scribers, made from steel rod
8	6 in. steel rules
8	4 in. trysquares
2	8 in. hacksaws

2 8 in. straight shears (snips),—"No nip" type
4 wheelbraces
2 drillplates, with drills, centrepunch and countersink,—see p. 412.
1 set of B.A. taps and dies,—see p. 412.
2 spring dividers for marking out.
1 scraper for removing solder.

Much might be done with less than quoted above, but it is advisable to counteract, from the beginning, the disadvantages of serious under-equipment.

Further special items.—These will be needed at convenient points around the room. A small part of one bench with a gas supply can be covered with asbestos sheeting, framed with wooden batten, to serve as a soldering bench. It should carry a heating stove and two soldering bits, 2 oz. and 4 oz. A mouth blowpipe, Fig. 22, and a 2 in. vice are additional accessories which will be found useful. In another place one might have a small hand operated emery wheel and an oilstone, the former being necessary if the school possesses no metal work centre. A drying oven, made from a 7 lb. biscuit tin should also be fitted up somewhere. Where glassworking is to be carried out, a second section of bench in a position free from draughts will need to be covered with asbestos. This is fitted with foot bellows, blowpipe, small glass rack and a few glass working tools. A small anvil of some kind brings this part of the equipment somewhere near to completion.

Storage of materials.—This is the next consideration. Racks or cupboards are needed, one for wood, one for sheet metal, and a third for rod and tube. For this and similar purposes, good use might be made of the available wall space. A large nest of drawers will be found convenient for accommodating scrap metal of a useful size, odds and ends of materials, mechanisms with possible uses, nails and screws. Shallow drawers may be divided into labelled sections, one drawer holding nails of several sizes, another iron woodscrews, a third brass woodscrews, a fourth nuts and bolts and terminals in B.A. sizes, while a fifth will be useful for washers, rivets, etc. Since, in many cases, science handicraft will form but part of the Science practical work, it may appear that the equipment is likely to encroach too far on the available working space. In small laboratories this may be a significant tendency, but it will not be so unless the room is normally overcrowded. It should be remembered that one is generally dealing with small models, which demand the storage of only small quantities of materials, and that the vices may be placed in such a position along the bench that they do not interfere with its use for other purposes.

Electrical equipment.—The electrical equipment of the room will depend on the nature and extent of the other practical work in the science course. Reference to wiring is made on page 447. Whether on A.C. or D.C., the laboratory should have a ready supply of low voltage D.C., probably from a battery of accumulators, housed in a box and kept in order by a trickle charger, so that the models may be tested. If the benches are wired from such a battery (Fig. 67) the circuit should incorporate a master switch, and an ammeter as a check on the discharge rate and to ensure that no branch circuit is left closed at the end of the lesson. Low voltage A.C., for running synchronous motors, lighting lamps, etc., may be provided by the transformer described in the next chapter.

SOME MORE ADVANCED MODELS

The models chosen for this chapter have been selected because of references demanded in the foregoing text.

A transformer.—A mains transformer, operating from 230 v.–240 v., giving an output of 4 amp. at 12 v., may be made in the following way. First obtain 4 dozen pairs of stalloy stampings,[1] which when assembled will give a core, ¾ in. by 1¼ in. cross section, and winding windows 3 in. by 1 in. Make a rectangular wooden block, 2⅞ in. long by ⅞ in. by 1⅜ in., drill it centrally through its length to take an axle, and screw a wooden end plate 3½ in. square to each end, Fig. 68 A.

The screws which fix one of them should pass through a drilled face-plate, *a*, (Fig. 68 A), carrying a bush and setscrew, so that the wooden former will rotate with the axle when on the winder, Fig. 68 B.

Remove one end temporarily, and build up a bobbin on the wooden core, previously smeared with vaseline, using 2⅞ in. strips of pasted paper to make the tube of the bobbin 1/10 in. thick, and strawboard for the ends. There will be no need for either the distance piece between the ends or the retaining collar, since the ends are supported by the wooden backing during the winding and will be held at the finish by insulating tape. Replace the wooden end piece, dry the bobbin thoroughly, and coat the accessible surfaces with shellac. Drill three holes through the wooden and cardboard ends (Figs. 68 A and 68 C), to allow the leads of the secondary coil to pass through. See that the stampings fit into the hollow centre of the bobbin before proceeding further. There should be just 1/16 in. clearance on each side which will be taken up, partly by the taping and partly by strips of packing at the final assembly.

The secondary (output) coil is wound directly on to the bobbin with 17 g. D.C.C. copper wire. Pass about 12 in. of it from the inside through the first of the three holes in the bobbin end, as at *b*, and secure it round a small nail in the wooden end piece. Then wind the first layer, ensuring that each length lies flat on the core. After each few turns have been laid on, push them up towards the starting end to make certain that they are closely packed. Count the number of turns on this first layer, and coat it well with shellac varnish. In all, the secondary requires 106 turns to give a 12 v. output, and since we need 6 v. also, a tapping must be taken at the 53rd turn. (The tappings may be taken at any point along the secondary circuit according to the voltage required, the voltage drop being proportional to the number of turns. Thus if we need 4 v., it would be taken off after one-third of the secondary had been wound on.) Continue winding the second layer, then, until 53 turns have been laid, then in the centre of the broad face of the coil bend the wire at a sharp right angle, carrying a loop out through the centre hole in the end, and back again to where the first bend was made (Fig. 68 C, *c*), leaving a 6 in. length outside the bobbin. Bind the two bends together with a few turns of cotton and continue the winding. Arrange for the turns to be closely packed at each end of the final layer, probably the third in this case, any widely spaced turns being placed near the middle. Then bring the end of the wire from the last turn back along the face of the coil and out through the third hole, Fig. 68 C, *d*.

Before starting on the primary winding, the two coils must be well insulated, and a firm foundation provided for the primary coil. Cut a strip of thin card, or heavy cartridge paper just wide enough to cover the wire and to touch each end of the bobbin,

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[1] Grafton Electric Company, 54 Grafton St., W.1.—Stampings No. 12/25.

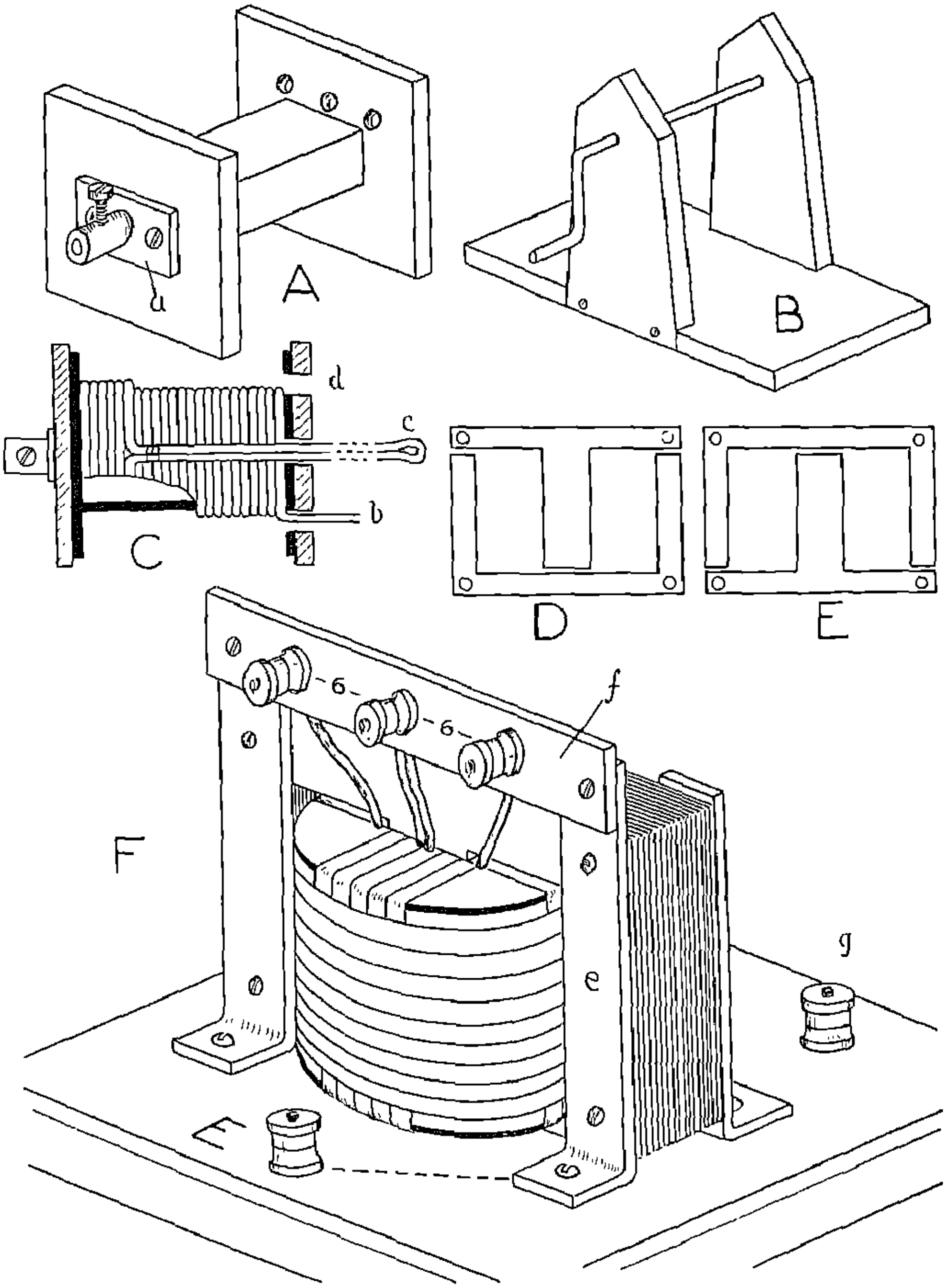

FIG. 68. A MAINS TRANSFORMER

A. Rectangular wooden block with end plates. B. Winder. C. Bobbin, partly wound. D and E. Arrangement of core stampings. F. Completed transformer.
a. Drilled face plate. *b*. Secondary end. *c*. Centre tapping. *d*. Hole for other end of secondary. *e*. Supports. E. Earth terminal. *f*. Bakelite or ebonite panel. *g*. One of two mains terminals.

wrap it twice round the coil, securing the end with gummed paper, and coat it with shellac varnish. Two or three further layers of waxed unglazed paper, will complete the insulation. 28 g. D.C.C. wire is a suitable material for the primary. Leaving 12 in. free and securing the first turn with a half hitch, wind it straight on to the foundation, layer after layer, until 1,960 turns have been laid, treating every second layer with shellac varnish.

Arrange for the two ends of the primary to leave the coil on the opposite side to the secondary leads, and at the other end; i.e., as far away as possible. When the complete coil is wound, bind it with a layer of insulating tape, as if winding on more wire, but with each turn overlapping half of the previous one, giving in effect a double layer. Trim the bobbin ends to within ⅛ in. of the coil, cover the five leads with insulating sleeving, slit for ½ in. at the end near the coil, and bind up through the centre and over the four faces of the coil with more tape, opening out the slit ends of the sleeving and binding them in at the same time. Leave the four corners of the coil unbound to avoid congestion in the centre of the bobbin. Finish off with a third taping, a repetition of the first.

Now insert the core stampings, one pair at a time, alternating them so that odd pairs are arranged as in Fig. 68 D, and even pairs as in Fig. 68 E. The overlapping thus obtained at the junctions of U and T pieces gives a freedom from large air gaps in the core and makes for greater efficiency. Tap the stampings lightly into position and pass 2 B.A. bolts through the four corner holes. As supports (Fig. 68 F, *e*), cut, drill and bend four lengths of iron bar, ½ in. by ⅛ in., and bolt them to the core as shown. Arrange later for a soldered lead to be taken from the foot of one support to an earth terminal (E in Fig. 68 F), which may be connected to a water pipe or other efficient earth when the transformer is in use. The two secondary leads and centre tapping are soldered to terminals mounted on a ¼ in. ebonite or bakelite panel, bolted to the front supports which are 1 in. longer than the other two in order to accommodate the panel. ¼ in. distance pieces cut from a metal tube and placed between the supports and the panel, bring the latter out from the core enough to allow the free passage of the leads to the back of the terminals. The primary leads are taken down from the coil through holes in the baseboard, and lie embedded in paraffin wax within grooves cut in the underside of the board. These lead to the two mains terminals, one of which is shown at *g* in Fig. 68 F, one wire running directly to its terminal while the other passes to a switch before continuing to the other terminal. The mains connections are placed at the back of the transformer in the interest of safety. Instead of being placed between the mains terminals, the switch might be brought to the front to serve as a local control, though in general the control will be at the wall switch. If the reader should wish to design his own transformer, using other stampings than those mentioned above, he is referred to *Small Transformers*—Model Engineer Series, by Percival Marshall.

An alternative.—Some constructors might prefer to increase the thickness of the stalloy core in order to reduce the amount of wire required. With 1⅛ in. depth of core in place of ¾ in., the secondary will need 70 turns, and the primary 1,310, to give the same output as the transformer described above.

Buy the wire in 1 lb. spools to avoid the possibility of having to make a soldered joint in the course of the winding.

A three-pole motor.—On page 400 will be seen a reference to a three-pole armature and an enclosed field as the two remaining important steps in the development of the electric motor and dynamo. A three armed armature, cut from 16 g. sheet iron and mounted on a spindle in conjunction with a three section commutator could be used to replace the two-pole armature system in Fig. 7. It works, but rather inefficiently, and may appear, to a boy who is judging by performance, to be a retrograde step. To illustrate the self starting quality of the three-pole motor, it would be advisable to use another model altogether. The model shown in Fig. 69 is very effective in starting, but has very little power, of course.

The armature (Fig. 69 *a*) is cut from tinplate and soldered to a length of knitting needle as an axle. The ends of the three arms are bent down and under to accommodate the coils (Fig. 69, *c*, *d*, and *e*) wound with four layers of 26 g. wire, all in the same direction. The input end of one, together with the output end of the next are soldered to one segment of the commutator,—see the wiring diagram.

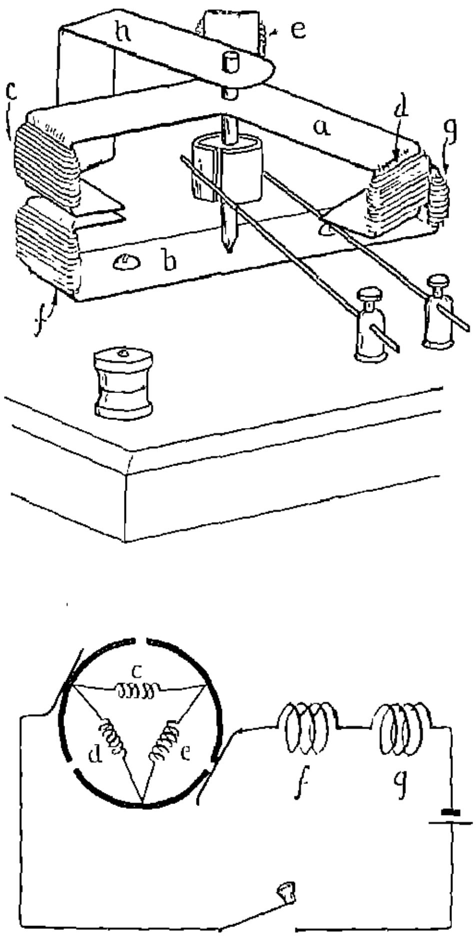

FIG. 69. A LIGHT THREE-POLE MOTOR

a. Armature.
b. Field core.
c, *d*, *e*. Armature coils.
f, *g*. Field coils.
h. Support.
Below.—The wiring diagram.

Another strip of tinplate bent up and over at each end, centrepunched in the middle and punched in two places for screws, carries the field coils (Fig. 69 *f*, and *g*) which are wound in series and connected in series between one brush and the battery. The other brush leads, via a terminal and key, to the other pole of the battery. A brass strip, bent twice at a right angle, serves as a plain bearing for the upper end of the shaft. Hammered copper wire, housed in screw terminals for convenience, forms the brushes.

Before winding any coil on to tinplate or iron cores, the metal should be covered with some insulating material which also prevents a possible breakdown through chafing. One layer of adhesive linen tape, painted with shellac varnish and dried, is effective for this purpose.

Fig. 70 shows a similar motor with considerably greater power,—one which is capable of driving small models, and of operating at high speed.

The field magnet (Fig. 70 A) is cut from 16 g. sheet iron, and is bent along the broken lines as shown in side elevation in diagram B, Fig. 70. The pole pieces are bent to form arcs on a radius of $1\frac{1}{8}$ in. Drilled centrally with a $\frac{3}{16}$ in. hole, reinforced by a sweated brass bush and provided with a soldered bracket (Figs. F. and B, *f*), the field core acts as one support to the spindle. The core is supported, also, by a screw, countersunk, passing through a $\frac{1}{4}$ in. wooden distance piece into the baseboard. The other spindle support, in 16 g. iron, or $\frac{1}{8}$ in. brass, is shown in diagram D (Fig. 70) and in position at *d* in Fig. 70 B. $\frac{1}{16}$ in. holes are provided in the bushes for the purpose of lubrication. For the field coils and, later, for those of the armature, put on eight layers of 26 g. D.C.C. wire, taking care that the clearance is maintained between the armature coils and those of the field (Fig. 70 B, *i*). Insulate the sheet iron as above before winding.

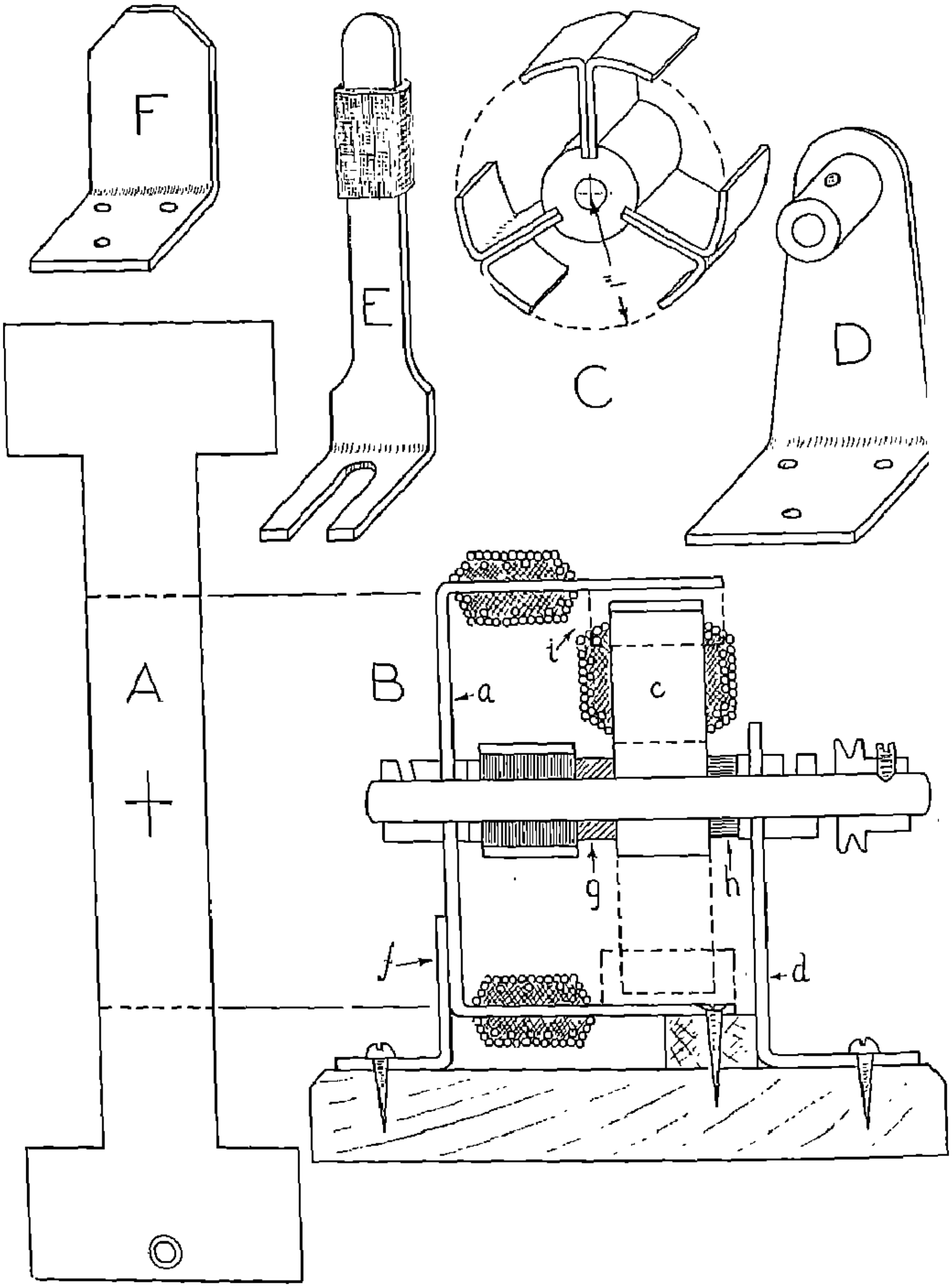

Fig. 70. A Heavier Three-Pole Motor

A. Field magnet. B. Section through motor. C. Armature. D. Spindle support. E. Contact brush. F. Soldered bracket.

a. Field core. c. Armature core. d. Spindle support. f. Soldered bracket. g. Ebonite distance piece. h. Brass distance piece. i. Clearance between armature coils and those of the field.

To make the armature (Fig. 70 C) drill a $\frac{3}{16}$ in. hole in a $\frac{1}{2}$ in. length of iron rod, $\frac{5}{8}$ in. in diameter. With a hacksaw, cut slots at three points and enlarge them with a file to $\frac{1}{8}$ in. width and $\frac{1}{8}$ in. depth. Cut six pieces of the iron sheet, $\frac{1}{2}$ in. wide and $1\frac{1}{2}$ in. long, and bend them to a right angle, leaving $\frac{7}{8}$ in. on one side of the bend. Two of these are then fitted into each slot, back to back, and filed so that they protrude $\frac{3}{4}$ in. from the outside of the central cylinder to the outside of the bend. The splayed ends are then bent to follow an arc of 1 in. radius. As each pair is fitted, hold them together with a rubber band, and mark the slot from which they came. When the three pairs are ready, clean up the surfaces in contact with the slots, flux them, fit the pairs, and bind round the outside of the assembly with iron wire. Place the armature flat on a horizontal board, drilled to take the shaft, pass the shaft through to the required distance, having cleaned it well where it passes through the central boss. Run in a little flux. Now make sure that all parts are accurately held in position, place beads of solder on and around each joint and run the solder in with a blowpipe flame.

When the armature is cool it is advisable to turn it over and run more solder in from the other side to ensure good joints. A soldering bit may be helpful for the finishing touches.

Multi-pole armatures may be constructed in a similar way. The coils, on an insulating foundation, are wound all in the same direction, as in the previous model, the beginning of the first and the end of the second being twisted together and soldered to one segment of the commutator. This is made from $\frac{5}{8}$ in. brass tube on a whitewood core, and is separated from the armature by an ebonite distance piece (Fig. 70 B), which is secured to both shaft and boss with liquid glue. In the final assembly, two $\frac{1}{16}$ in. brass washers, $\frac{3}{8}$ in. diameter, separate the field core from the commutator. Care must be taken that these do not extend far enough across the end of the commutator to short circuit the segments. A brass distance piece (Fig. 70 B, *h*) and a washer, separate the boss from the other support, *d*, in Fig. 70 B. This should allow the armature assembly a just perceptible movement between the supports. A small pulley may be fitted to the end of the shaft.

Finally, two brass brushes (Fig. 70 E) are prepared and are provided, if desired, with a strip of copper gauze wrapped twice round the brush and secured at the back with a touch of solder. Terminals are fixed to the baseboard in convenient positions, and connections, sunk into the underside of the base, lead from one terminal to the series wound field coils and from there to one brush. From the other brush a wire leads to the second terminal as in the wiring diagram, Fig. 69. While testing, move the commutator round to find a position of maximum effect, then secure it to the ebonite distance piece with a few touches of liquid glue.

Instead of building the armature, one might use stampings, obtainable from most model supply stores.

These are assembled on a steel axle, as in Fig. 71. Solder the first into place on the axle, build up the core to the required thickness and fix the last with more solder. The rest of the assembly can be as described for Fig. 70.

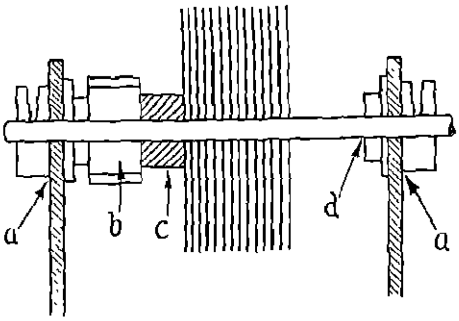

FIG. 71. AN ARMATURE BUILT FROM STAMPINGS

a. Bush.
b. Commutator.
c. Ebonite distance piece.
d. Collar, soldered or held by a setscrew.

A sensitive galvanometer.—Make a bobbin ½ in. from face to face, on a cylindrical former, 1¼ in. diameter, and wind it to a depth of ¼ in. with 28 g. D.C.C. wire. Construct the bottom, front and back of the case with ½ in. board, and the sides with plywood, Fig. 72. To the back of the case glue a cork (Fig. 72 B, *a*), on which the bobbin will just fit tightly, and with the bobbin in place solder the ends of the wire to two terminals. Through a hole bored in a piece of cork pass a ⅞ in. length of magnetised knitting needle, fix a pointer of glass capillary tube in the face of the cork, which is then connected to a large pin with an unspun silk fibre held at its ends by spots of liquid glue. With the pin thrust into the cork, the magnet should swing freely just inside the coil. Small clips made from sheet brass hold the glass cover in position. By

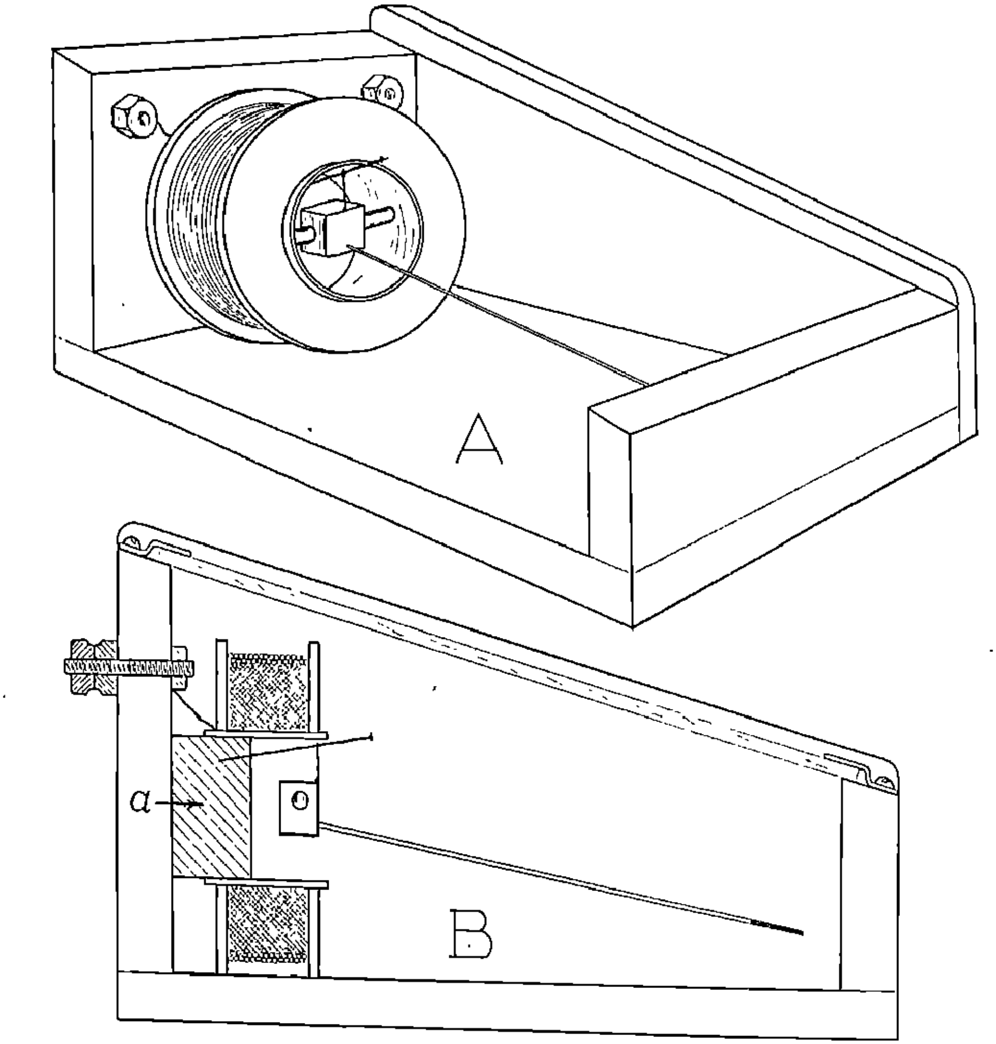

FIG. 72. A GALVANOMETER

A. Perspective view, partly sectioned.
B. Sectional elevation.
a. Cork glued to back of case.

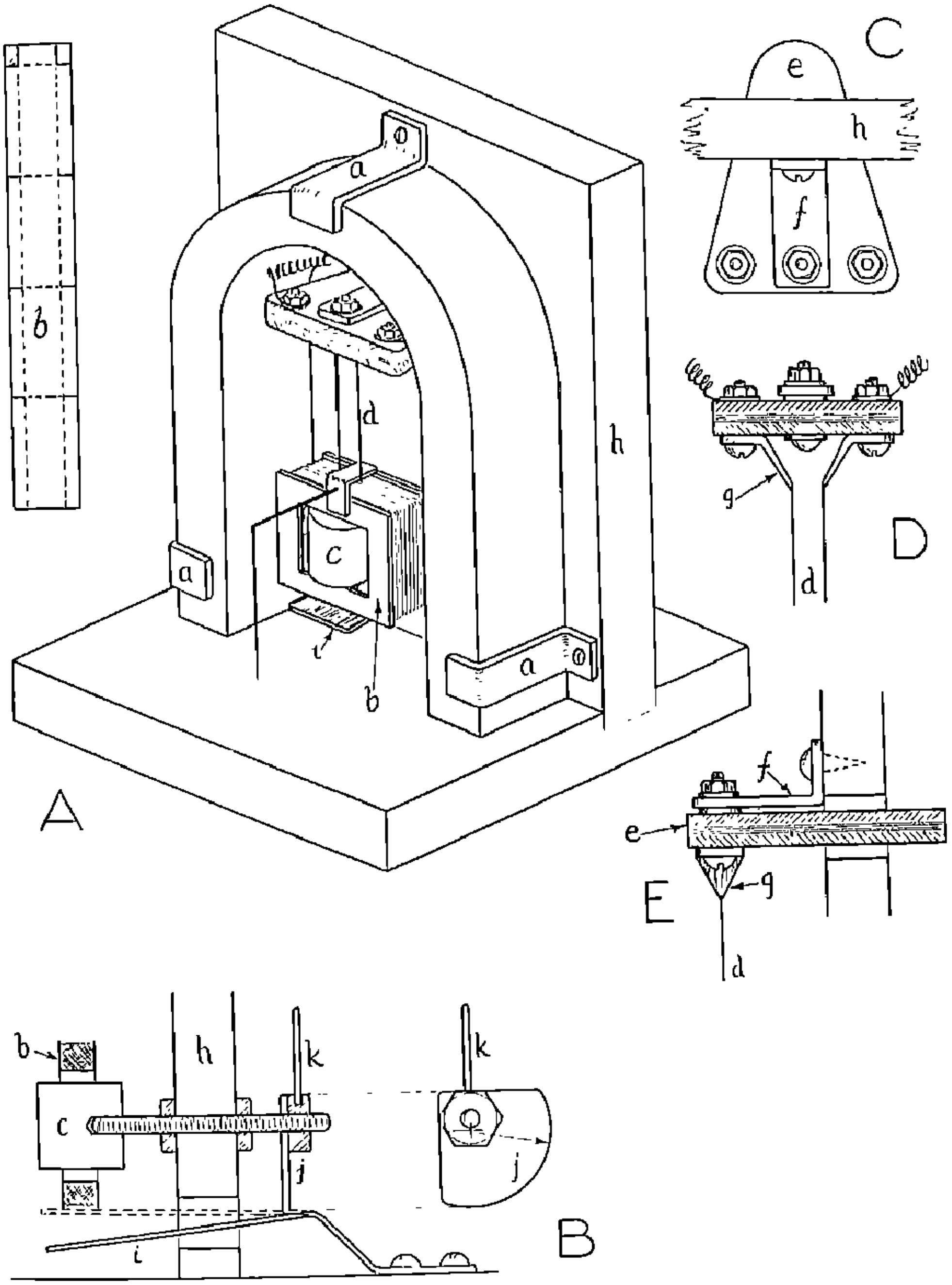

FIG. 73. A MOVING-COIL GALVANOMETER

A. The completed galvanometer. B. Arrangement for securing coil when not in use. C. Suspension in plan. D. Front elevation. E. Side elevation.

a, Clips. *b*, Bobbin. *c*, Round soft iron rod. *d*, Wire suspension. *e*, Plywood or ebonite arm. *f*, Brass arm. *g*, Strip of brass. *h*, Upright. *i*, Flexible brass strip. *j*, Cam. *k*, Operating lever.

means of a small control magnet the pointer may be brought to a zero position on the scale which is cut from cartridge paper and glued to the bottom of the case. This is quite a sensitive instrument. Three magnets, one below the other, and with the same polarity, might be used in place of the one shown, to increase sensitivity.

A moving coil galvanometer.—A horse shoe magnet from an old loud speaker unit is fixed by clips, *a* (Fig. 73), to an upright, *h*, housed in a baseboard as in Fig. 73 A.

The coil is wound with 32 g. enamelled or D.S.C. wire, to fill a bobbin, *b* (Fig. 73 A), made from thin copper or brass sheet, the ends of the wire being twisted together, once round, and brought out on either side of a bent strip of brass, soldered to the face of the bobbin, nicked with a file to house the wires, and coated with shellac varnish. A light pointer is glued to the bobbin. The suspension is shown in plan, front elevation, and side elevation, at Figs. 73 C, 73 D and 73 E respectively. A plywood or ebonite arm, *e*, (Fig. 73 C) is joined by the central nut, bolt, and washers, to a brass arm, *f* (Fig. 73 C), a hole having been cut in the backboard, *h* (Fig. 73 C), to allow it to project through to the back and to permit a certain lateral movement. The outer nuts and bolts hold in position two strips of brass, *g* (Fig. 73 D), bent and filed to points to which the wire suspension, *d* (Fig. 73 D), may be soldered. Leads from terminals in the baseboard are soldered to the upper part of these two bolts. Fig. 73 B shows, in section, the arrangement for securing the coil when not in use. A length of round, soft iron rod, *c* (Fig. 73 B), is drilled and tapped, and fixed centrally between the field poles by a threaded rod, passing through the backboard and held by nuts. No more than $\frac{1}{8}$ in. clearance all round should exist between the core, *c* (Fig. 73 B), and the coil, *b*, Fig. 73 B. A strip of brass, about 24 g., bent as shown at *i* (Fig. 73 B), and passing through another hole in the backboard, to be secured to the base, is adjusted so that in its free state it may spring up just past the dotted line position, to jam the coil up against the core. When the instrument is in use it is depressed by the movement of a cam, *j* (Fig. 73 B), arranged to rotate freely along the thread of the rod which holds the core. The cam is cut as a sector of a circle whose centre is shown, and is sweated eccentrically to a nut which carries the operating handle, *k*, Fig. 73 B. A circular scale and a cover box complete the model after levelling screws have been fitted to the base.

Since the sensitivity of the galvanometer depends on the flexibility of the suspension, it will be improved by replacing the existing suspension wires by the finest copper wires one can get, say about 40 g., these being soldered to the ends of the coil winding just above the bent strip which separates them.

This design could be modified for a single, instead of a bifilar, suspension. The phosphor-bronze strip would be fixed centrally to the adjusting bar, *e* (Fig. 73 E), to rotate with it, and the locking spring, *i* (Fig. 73 B) would need to be cut away in the middle to allow the wire from the coil to be taken down in a spiral to a contact in the baseboard. The dimensions of the coil are governed by the breadth of the gap between the poles of the field magnet. From face to face, the coil should be narrow. It should just be able to clear the magnet when completely rotated. If the gap is too great, it may be worth while taking up some of the space by inserting soft iron pole pieces.

A projection lamp.—A projection lamp producing a beam for throwing shadows of experiments, illuminating water ripple tanks, projecting a series of rays for light experiments, and to serve as an illuminant to be used in conjunction with the objective of a microscope in constructing a microprojector can be made in the following way.

First obtain a car lamp—12 v., 48 watt if used with the transformer described on page 450—with a coiled filament, and a pair of condenser lenses,[1] about 35 mm. diameter.

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[1] The Miscellaneous Trading Company, 13 New Oxford St., London, W.C.1, supplies such lenses.

Arrange the system temporarily to find the relative positions of the lamp, condensers, and focus. Place a microscope slide almost at the focus and find an approximate position for the objective. When the distances have been found by experiment, the dimensions of the lamp house may be determined to suit.

A rectangular hole, cut in the top of a tin canister, with its edges turned up along the line (Fig. 74 A, *a–a*) to act as light screens, is covered with tinplate (Fig. 74 A, *b*), soldered into position. A hole large enough to admit the lamp is cut in one end, and a sheet of brass, *c* (Fig. 74 A), not quite as large as the end, is prepared to cover the hole. In this, a hole is made to take the lampholder, *e* (Fig. 74 A), and to it are sweated two brass prisms, *f* (Fig. 74 A), and a bracket drilled and tapped 4 B.A. This allows lateral movement controlled by screws operating through plates sweated to the tin, drilled and tapped 4 B.A., and vertical adjustment by another screw passing through an oversize hole in the plate, *d*, Fig. 74 A. Holes are drilled round the base for ventilation. At the other end the lid is reinforced by soldering a face plate to it. A hole is

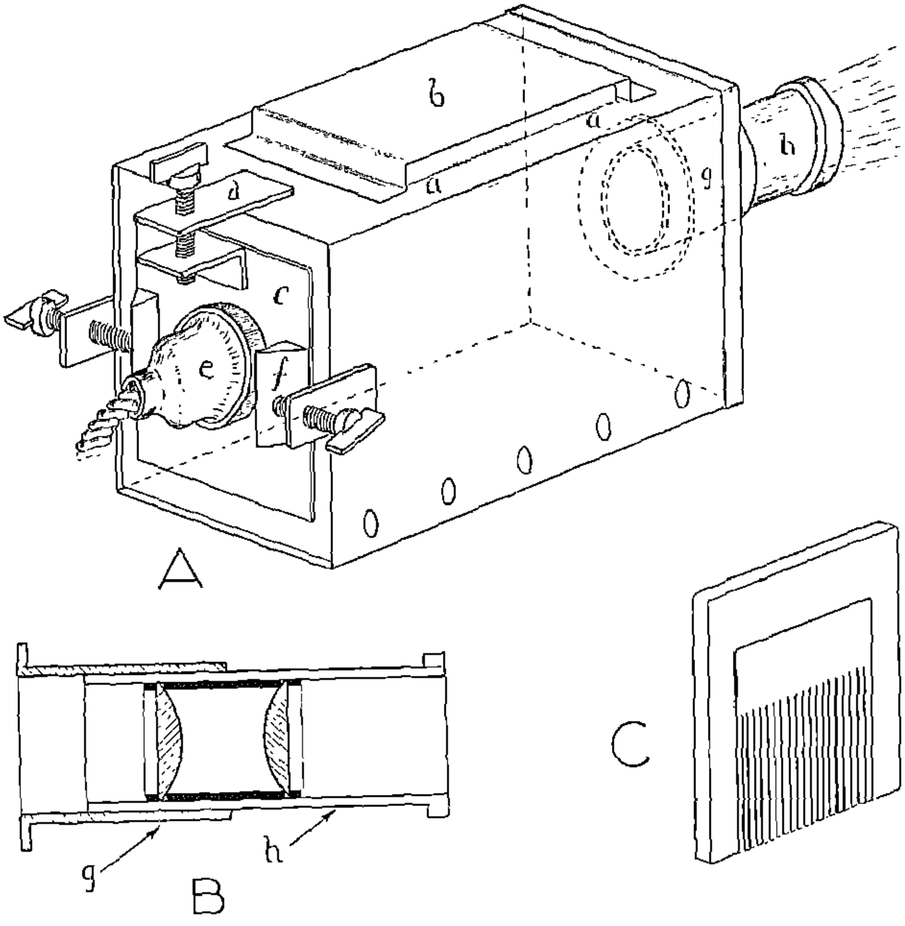


Fig. 74. A Projection Lamphouse

A. *Completed lamphouse.* B. Condenser system. C. Grainer's comb for ray projection. *a–a*. Line of bend. *b*. Tinplate. *c*. Sheet of brass. *d*. Brass strip. *e*. Lampholder. *f*. Brass prism. *g*. Brass tubing. *h*. Second tube.

then cut in the plate to take about 1 in. of brass tubing (Fig. 74 A, *g*), which is soldered into place. A second tube, *h* (Fig. 74 A) slides fairly freely inside the first and carries the two condensers, which are held in position by rings of brass wire sprung into place, and separated by a ring of sheet brass about ½ in. wide, serving as a distance piece, Fig. 74 B. A ring of square copper or brass wire soldered to the outside at the end of the smaller tube gives a finish to it and acts as a grip. The tubes may be made by tapping strips of 24 g. brass round a former with a mallet, filing to give a good fit at the edges, and soldering. The smaller tube, lightly vaselined, may be used as a former for the second if its own former is still in position to prevent distortion. If desired, the whole lid may be soldered to the canister, but some advantage may be found if it can be removed and replaced by another lid (Fig. 74 C), cut away to give a rectangular hole which is covered by a piece of a grainer's comb. This will give good rays for demonstration work. A round tin could be used with very few modifications to the design given here.

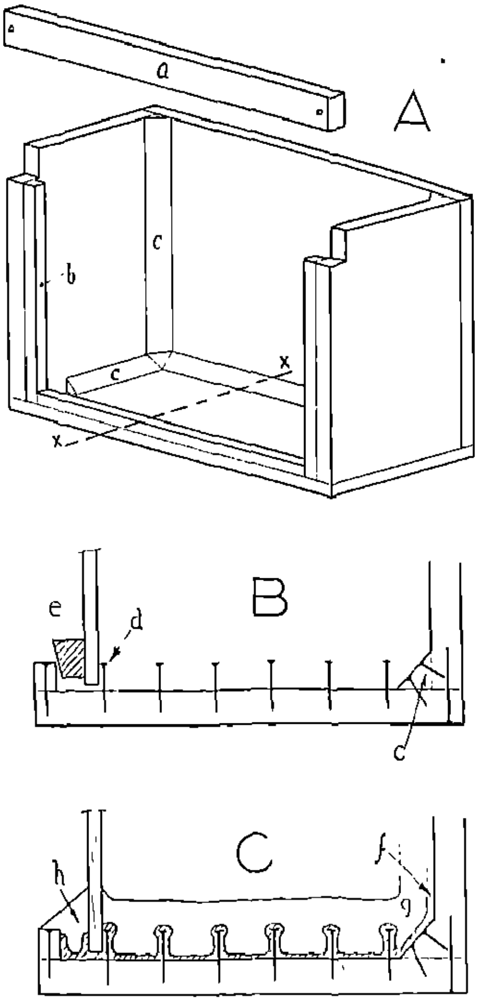


FIG. 75. AN AQUARIUM

A. *a*. Strengthening crossbar.
b. Fillet of wood.
c. Triangular section.
x–x. Line of sections B and C.
B. *d*. Nail.
e. Glass wedged against nail.
C. *f*. Melted pitch.
g. Concrete.
h. Front channel concreted.

An aquarium.—An aquarium costing only a few shillings may be made as follows. Nail together the base, back, and two sides of a box made of wood ¾ in. or so thick. Cut recesses in the two free corners of the sides to take a strengthening crossbar, (Fig. 75 A, *a*), which will be screwed in position later. Nail fillets of wood (Fig. 75 A, *b*), ½ in. by ½ in., to the inside of the face opening, and smooth out the inside angles by nailing into them some pieces cut along the diagonal of some 2 in. square timber to give a triangular section, *c*, Fig. 75 A. Mark a line along the base and up each side, ⅝ in. in from the inner face of the fillet, and drive nails into the base and sides along this line to act as retaining stops for the glass Fig. 75 B, *d*. Get some heavy window glass or plate glass, slide it into position from above, and wedge it firmly against the retaining nails as at *e* (Fig. 75 B), testing it for fit and then removing it. Now drive 1 in. wire nails halfway in, all over the base, back, and sides, at a distance of 2 or 3 in. from one another. Melt some pitch and pour it to cover most of the base to a depth of about ⅛ in., leaving uncovered only that part near to the position of the glass. Turning the box on its back, and on each end, continue the coating of melted pitch over the back and sides. A hot piece of iron will be found useful for working the pitch fairly evenly over the wood. A bunsen flame passed over the surface ensures that the layer of pitch is continuous; there is no danger of fire, though a momentary flame may appear around the head of a nail which is getting overheated. This goes out as soon as the flame is removed. Reasonable care should be taken, of course, to guard against over-heating.

Now roughen a border, about ¼ in. wide, on both sides of the glass by rubbing each edge with emery cloth moistened with turpentine or paraffin. When cleaned with a dry rag, this assists the pitch to stick to the glass. Put it in position, fit the crosspiece (Fig. 75 A, *a*), wedge the glass and run in some more pitch to continue the coating up to the glass, to make contact with it, and to run through to the outside. A little more pitch, or preferably Chatterton's compound, should be added to the trough outside to make it waterproof also. This is done along the base and up the two sides; the top need not be so treated. Spring some ½ in. mesh wire netting tightly over the nails inside the aquarium to reinforce the concrete with which it is now to be lined, and to assist in supporting it on the back and sides while setting.

Before concreting, put the aquarium in its permanent position, as it should not be moved when once lined with concrete,—in any case it will be very heavy by then. Mix about 3 parts of sand with 1 part of cement, and slake it with water taking care not to make it too wet. Experience will soon show the right degree of moistening. Line the whole of the inside up to the glass with about ¾ in. of concrete and fill in the front channel, Fig. 75 C, *h*. The woodwork is then painted. To complete the aquarium, a wall may be made, enclosing part of the floor, by building up small pieces of coke well coated with cement wash, and pouring a little of the wash,—at the consistency of cream,—to fill in the spaces between them. This will serve to hold some soil in which water plants may be rooted. An arch to give shelter to those fish which need shade, may be constructed in the same way. This aquarium may be populated with plant and animal life after three weeks' soaking, with about six changes of water, gravel being added during the later changes.

Goldfish.—If goldfish are kept in the aquarium, the following notes on their care may be useful:

Arrange that all the children who wish may look after the fish for a day in turns, and make a list with dates. Then explain what should be done. Each day a good deal of the water should be baled out with a small jug, and fresh added, *which was drawn ready the day before.*

The fish can be fed on tiny worms, scraped meat, or ready-prepared fish food or ants' eggs. It is best to give variety, with some fresh food. A small pair of forceps or scissors is best for giving them the meat, which should be snipped off and fed to them individually by dropping tiny pieces (¼ in.) in front of them. Never leave any uneaten food in the bowl, or it will attract a fungus which may kill the fish. A small muslin net on a cane or galvanised wire frame should be made for skimming the surface, or a little sieve can be bought.

Once a week the fish should be put in another vessel while the bowls are drained, their sides sponged, and they are refilled. (This is best done by the teacher.) If a tap and some rubber tubing are available this can be done by siphoning without disturbing either the fish or the bottom. An occasional brine bath is good, especially if the fish show signs of lassitude or lose the brightness of colour. Any fish attacked by fungus should be isolated. Brine baths may cure it.

REPAIRS IN THE HOME

WATER TAPS

OF all the little inconvenient defects which can develop in a home, a faulty tap is probably one of the most irritating. Ordinary taps are prone to two types of leak. The more common one is due to a worn out washer which fails to cut off the water supply completely, and the other is caused by inadequate packing in the tap gland which permits water to trickle out at the top round the handle spindle. Although a gland leak shows itself only when the tap is being used it is none the less objectionable as it leaves unsightly streaks on the external metalwork.

Opening a tap.—Before a tap can be opened to effect a repair, the water supply must be turned off at the main. The control intended for this purpose is an ordinary tap fixed in the main pipe either near the point where the supply enters the house or just outside in a hole below a small grate. Sometimes one main tap regulates the supply to several houses simultaneously, and in such cases the neighbours should be warned before repairs are begun. A main tap is sometimes stiff to turn owing to neglect. If it cannot be loosened by being alternately turned backwards and forwards, with a gradual increase in the amount of twist, then the trouble should be reported to the water supply authorities.

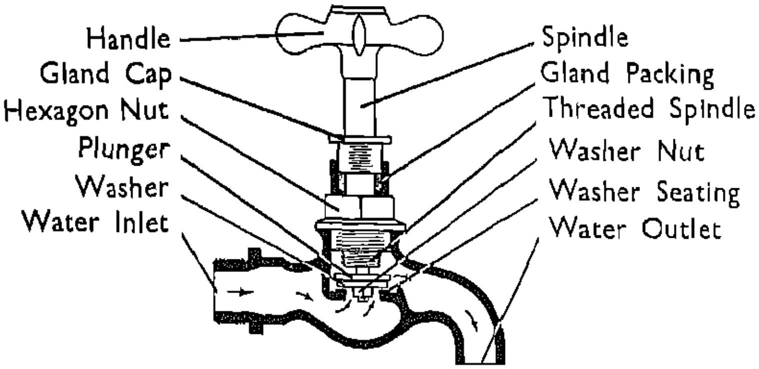
After having turned off the main tap successfully, the water in the house pipe is run off by opening the faulty tap and allowing it to drain. The preparatory procedure just described is effective with either hot or cold water taps, although hot taps will take a long time to drain as the large cistern in the house has to be emptied. Time spent in draining a hot tap can be reduced if the cistern has a tap in its base, as this can be turned instead of cutting off the main supply.

Assuming that the tap to be repaired is one of the modern enclosed kind, the next job is to unscrew the upper part of the case. If a pipe gripping tool has to be used for this purpose, the jaws should be packed so that the metal may not be damaged. The large hexagon nut under the case is unscrewed by means of a spanner, the loose part of the tap case being held up out of the way. When the nut is clear of its thread the whole of the mechanism comes away.

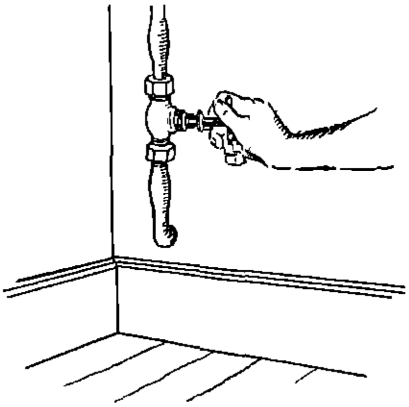
Changing the washer.—The old washer is released by taking off the small nut immediately below it; it is then slipped off its stud. A new washer, made of leather for a cold tap or rubber composition for a hot one, is put in place and the retaining nut is tightened up again. After trying the whole assembly for fit and freedom of movement in the body of the tap, the large hexagon nut is screwed down and the case top replaced.

A leaky gland.—No preliminary turning off or draining is necessary when a gland repair is to be done, but the tap handle and case top have to be removed so that the packing box may be opened. When the box cap has been screwed out, white stringy packing will be visible round the tap spindle. If this is lumpy, hard, powdered or badly discoloured, it should be replaced by a new lot obtained from the plumber. The packing should be pressed firmly round the spindle so as to make a watertight joint, and the cap should then be screwed down. If the cap is too slack, the gland will leak, but if too tight the tap will be uncomfortably hard to turn. The case top and handle are refitted when work on the packing box is finished.

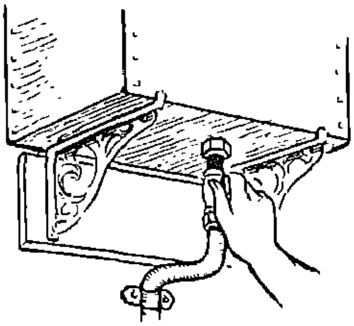
Before putting the tap into service, the screw action of the handle should be tested for range of movement and smoothness. If it is normal, the main tap, or the cistern tap as the case may be, is turned on and the overhaul is completed.



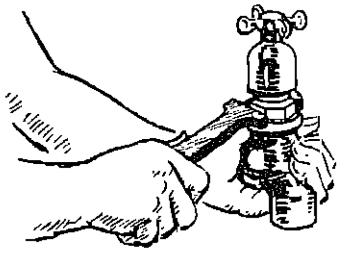
SECTION OF HOUSEHOLD TAP



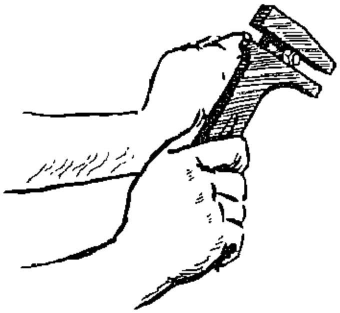
TURNING OFF AT THE MAIN



TURNING OFF AT THE CISTERN



REMOVING A TAP MECHANISM



REMOVING THE WASHER NUT FROM THE PLUNGER

PLATE I
WATER TAPS

BLOCKED PIPES

Although the waste pipes fitted to wash basins and sinks are usually of fairly generous dimensions and can carry away a good deal of solid matter, partial or complete blockage does sometimes occur. The cause is generally an accumulation of tea leaves, vegetable scraps, mud, pieces of soap or fat. An obstructed pipe can be cleared most conveniently by working through the following routine.

If there is no great hurry, a treatment with washing soda should be tried first. The sink is baled dry and the waste pipe is then packed with soda crystals. This is left to act on the material in the pipe for an hour or more so that the obstacle may be penetrated. A bucketful of very hot water poured into the sink should carry the foreign matter away and leave the drain in good working order. As the soda and hot water remedy is not infallible, many people prefer to adopt more direct and active methods immediately.

The 'U' trap.—At the bottom of the 'U' shaped drain pipe under the sink or basin there is a small plug by means of which the water in the pipe, and possibly the obstruction also, may be drained away. This plug may be unscrewed with the aid of an ordinary adjustable wrench, but before doing this it is necessary to put a bucket or bowl in position to catch the discharge, as there is quite a lot of water in the 'U' even when the sink is empty. A pliable wire or a length of curtain spring can be used as a probe in the plug hole, but care must be taken or the tool may be lost in the pipe. If the seat of the trouble is near the 'U,' this simple probing is almost certain to be effective and the cure may be completed by a hot water rinse from the sink down the pipe into the bucket. When the plug has been replaced the trap is refilled by running the tap for a short time.

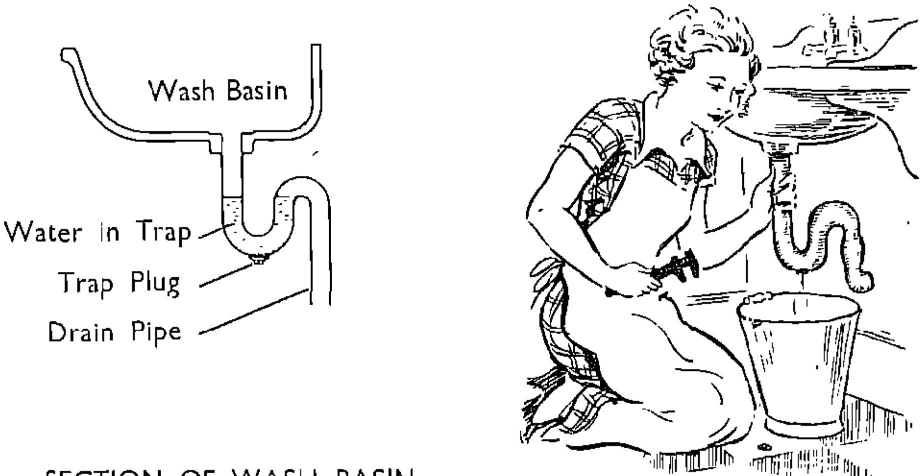
The drain cup.—The treatment just described does not entail the use of special apparatus, but if it fails to do the work, then a pumping tool must be obtained. This is sold under a variety of names, but is here referred to as a *drain cup*. It consists of a bell-like rubber cup with a short stiff handle. This appliance is placed over the drain hole in the sink and the handle is pressed down and pulled up rapidly and vigorously many times, after the fashion of a pump. The sink should contain hot water to the depth of 1 or 2 in. whilst the drain cup is being used.

After a few strokes, unless the blockage is a serious one, the water begins to make a way through and the action, continued for a few minutes, clears the obstruction completely. A final rinse is advisable as it removes foul water from the 'U' trap.

The drain cleaner.—There are flexible cables with fittings specially designed for drain cleaning, but for ordinary domestic purposes it is not usually necessary to purchase such a tool. A length of drain-clearing cane will serve very well for all household jobs.

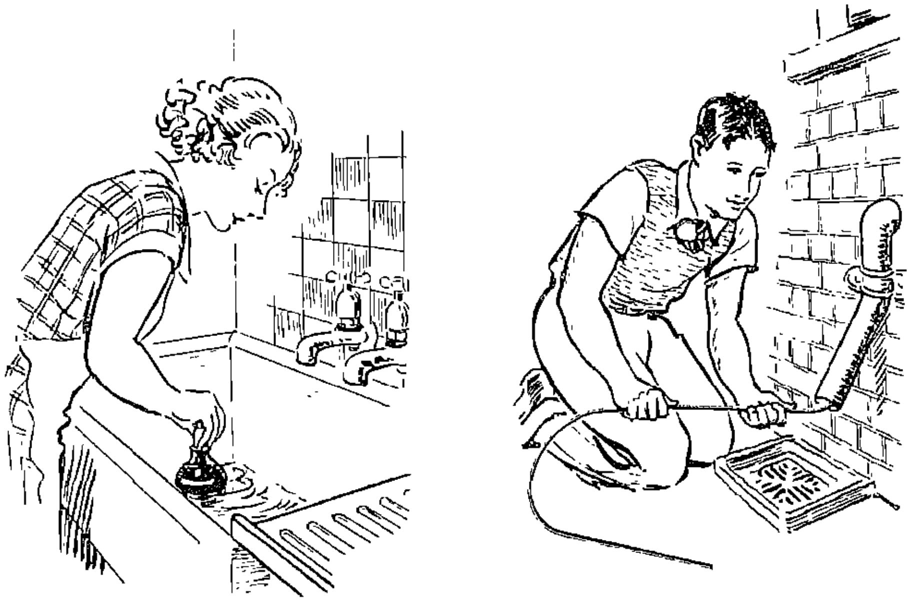
The 'U' trap probe and the drain cup deal with material in the pipe near the sink, and if they have failed the next treatment may well be applied to the outlet end of the drain. The cane is pushed into the pipe and then pulled back smartly so as to disturb any substance which may be lodging in its path. It is pushed again and the jerk repeated. By manipulating the tool in this way, a course for waste water is gradually cleared round the pipe bends right away to the trap. Once the cane has made even a narrow passage, hot water from the sink makes its way through and helps to enlarge it to a normal size.

Drain cane can be used in the sink outlet if desired, but the 'U' trap may be difficult to negotiate, particularly if the cane is at all stiff. Similarly, acute bends may prove an obstacle. In such circumstances, where peculiar troubles present themselves, and in cases where the blockage proves obstinate, it is wiser to bring in professional assistance than to adopt more drastic methods than those explained here.



SECTION OF WASH BASIN U TRAP AND DRAIN PIPE

DRAINING A U TRAP



USING A DRAIN CUP

INSERTING THE DRAIN CANE

PLATE II
Blocked Pipes

WATER TANKS AND BALL TAPS

The ball tap.—Entry of water into either flushing tanks or cisterns is controlled by a tap which is operated by a floating ball and lever. As the tank fills, the ball rises. In its highest position the ball lever holds the tap washer firmly on its seating and thus cuts off the water supply. An overflowing tank implies an imperfect tap, and the cause of the trouble is to be found either in the washer mechanism or in the ball and lever unit.

The ball and lever.—Before doing any dismantling, the automatic tap should be inspected and tested. The cylindrical washer container should slide freely when the ball arm is moved, and the ball arm itself should turn quite easily on its pin. This pivot should be in good condition as its function is of paramount importance; flooding is an inevitable consequence of pivot collapse.

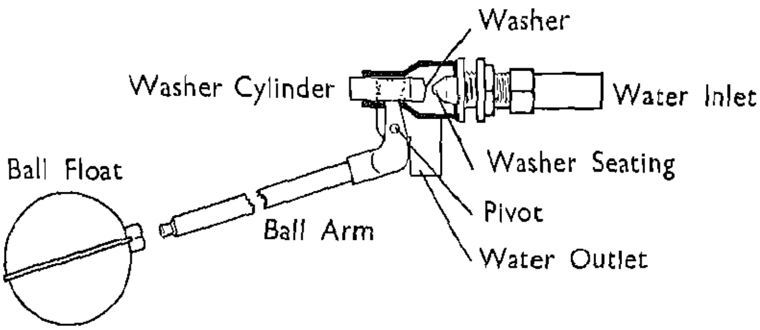
If the moving parts are found to be in order, the ball float should be unscrewed from the arm and removed from the tank. The tap may be kept closed whilst the ball is out of place by propping or tying the lever in the high position. If water can be heard in the ball when it is shaken, then the fault is a puncture. A leaky float is not usually worth repairing as probably the whole of its metal surface is weak, even though the part which has given way may be only small. If the ball is considered to be in fair general condition, however, there is no objection to emptying it and then repairing it with solder. In order to get rid of the water, a second puncture has to be made in the ball to serve as an air inlet. This is repaired along with the original one.

Sometimes a ball tap operates at the wrong water level as a result of wear and tear of the mechanism, and it may therefore be prevented from closing completely by the action of the overflow pipe. To any ball tap which fails to shut off the entire supply, the following simple test should be applied. When the tank or cistern is full and the trickle from the ball tap is a minimum, raise the float slightly by hand and note whether the little extra movement is effective in shutting off the supply. If it is, then a slight mechanical adjustment will correct the fault, but if not, the washer unit will probably be needing attention. The mechanical adjustment consists of bending the ball arm very slightly downwards so that a lower water level will be able to force the sliding cylinder to its off position. This kind of thing must not be carried to excess. If a slight bend does not correct the fault, then in all probability the real cause lies in the washer cyclinder, or in the pivot.

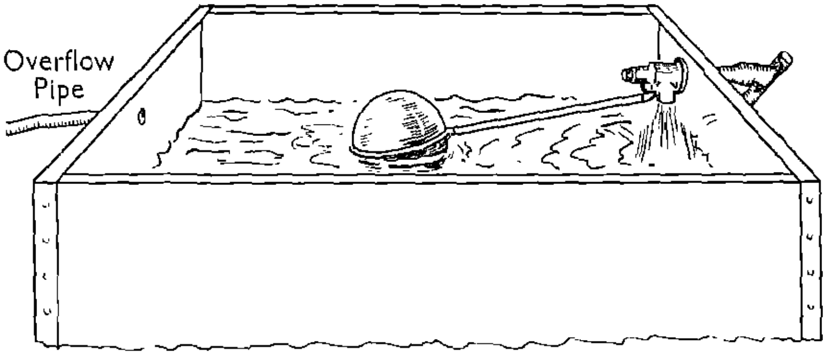
The ball tap washer mechanism.—This is a metal cylinder which slides in a tube. Near one end is a slot for the ball arm lever and at the other is the washer. Before any repair to this part of the apparatus can be started, the main water supply must be turned off and the pipe drained. The cylinder may then be released by removing the ball arm pivot.

To gain access to the washer, the end of the cylinder is screwed out. Usually the thread is very stiff and pipe-gripping tools have to be used after a few drops of paraffin have been applied to the joint. When the end piece is free, the small washer may be extracted from the inside and a new one of similar size installed. After being reassembled, the cylinder is fitted in its tube again with the ball arm in its slot; the pivot is replaced and the working of the appliance is tested. If it is in order, the main supply is turned on and the repair is examined again under working conditions.

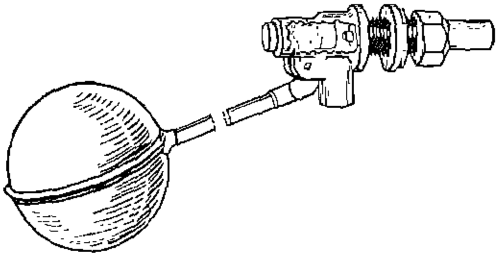
Erratic flushing.—This irregularity may generally be traced either to an inefficient pivot in the cord or handle operating arm or to an unduly low water level in the cistern, unless, of course, the flushing apparatus itself has developed an internal defect. If by trial it is found that rather more water in the tank overcomes the difficulty, and assuming that the position of the overflow pipe permits a higher water level, then the fault may be remedied permanently by bending the ball arm slightly upwards.



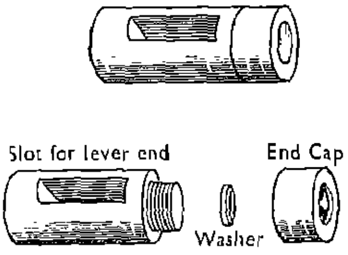
SECTION OF BALL TAP MECHANISM



BALL TAP CONTROLLING SUPPLY TO TANK



BALL TAP



DETAILS OF WASHER CYLINDER

PLATE III
WATER TANKS AND BALL TAPS

FUSE REPAIRS

When a group or all of the electric lights in a house fail at one time, then the cause is probably a melted or "blown" fuse. A fuse is a short piece of thin wire of low melting point included in a circuit as a safety device. When the current passing through it exceeds the limit to which the installation should be subjected, the fuse melts and thus breaks the circuit. The necessary repair can be undertaken quite confidently by an amateur who bears in mind one or two simple precautions.

Locating the fuse.—The only fuses fitted in small houses are to be found in the main ironclad switches near the meter, but in addition to these, in larger buildings, there may be one or more distribution boxes containing fuses. Certain domestic appliances, notably cookers, often have a set of fuses built in near the switch panel or on their control board. The position of every fuse in the house should be known.

If the breakdown affects only a part of the installation, then it is likely that the fuse has occurred in one of the subsidiary points; but if the whole house is without power, then the main fuses by the meter are likely to be the root of the trouble. The main house fuses should not be confused with the supply company's service fuses which are near the meter but which are sealed. The service points are fitted with stout wire and are not likely to give way. In any case, the householder is not permitted to tamper with them.

Ironclad switch cases can be opened to give access to the fuses only after switching off the current, but distribution boxes can be inspected without observing this precaution. It is strongly recommended, however, that the power be turned off completely at the main whenever repairs of any kind are to be executed. The slight inconvenience which this entails is more than counterbalanced by the sense of security which it gives.

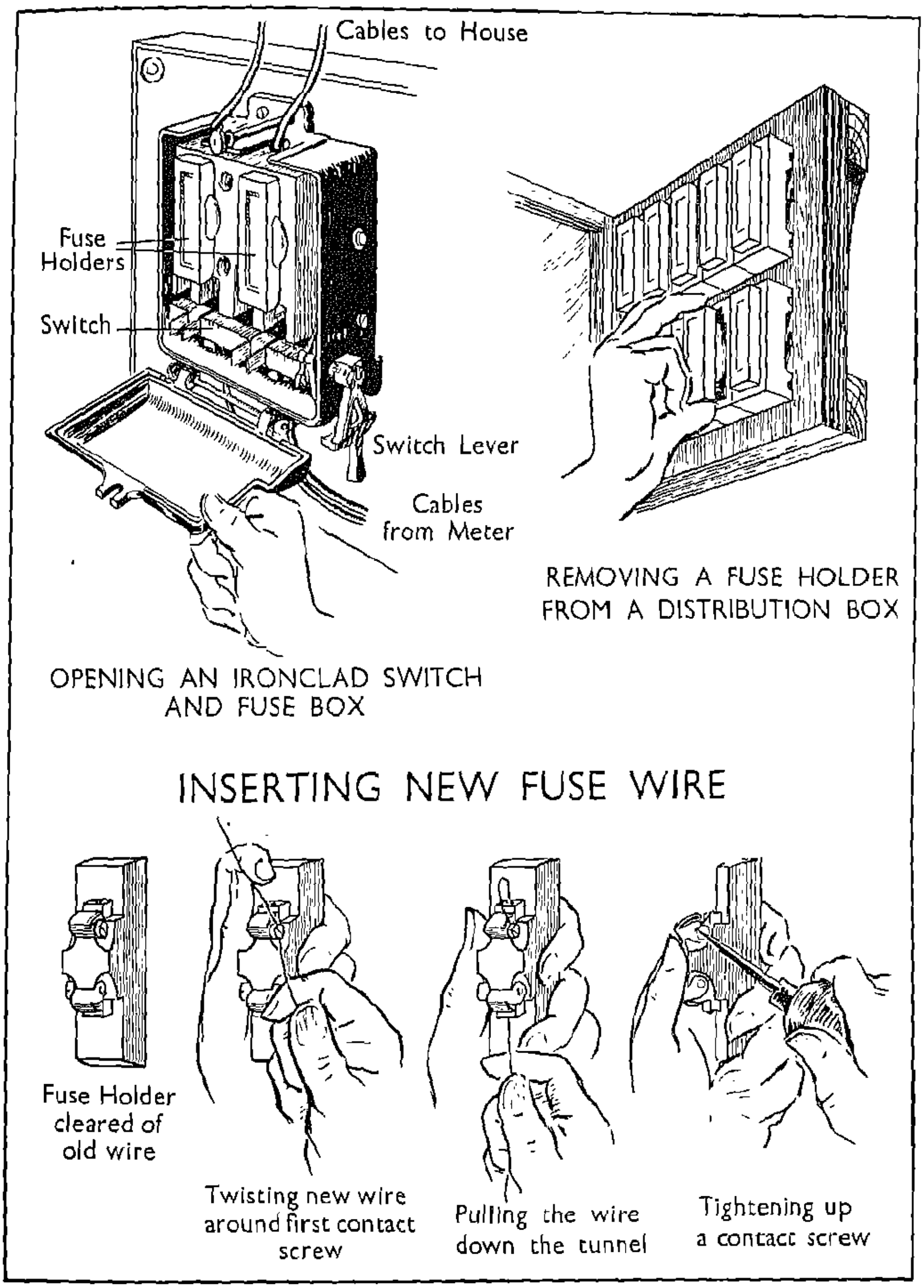
The porcelain fuse holders are push fits in their sockets. In order to locate the broken wire, the holders are pulled out one at a time and examined. When in good working order, the fuse wire is held securely at each end by a terminal or screw attached to the contact strips and is continuous. In many designs of fuse holder the wire is held in a tunnel or slot and so may be out of sight. A gentle pull on the wire near one contact strip will draw out the broken end if a fuse has occurred. This pull test may not be necessary as a brown stain on the porcelain often attracts the observer's attention to the break, but the test is very useful when all visible signs of fracture are hidden in the tunnel.

Renewing the fuse.—After the holder with the broken wire has been found, the bits of fuse still remaining on the screws or terminals are removed. A new length is then cut and fitted, care being taken to see that the wire lies in the tunnel or groove prepared for it in the holder, that long ends do not protrude from the contacts and that the screwing down of the clamping screws or terminals does not cause the wire to be damaged.

Any old scrap of wire will *not* do for a fuse. Cards or small reels of proper fuse wire can be bought from an electrician. The short lengths taken out of the holder will suggest the kind of replacement material which is required, but it should be remembered that it is better to err on the thin side rather than the thick. As a general rule, 5 amp. wire is suitable for lighting circuits and 10 or 15 amp. for most power lines.

A fuse having been found and repaired, it must not be assumed that the circuit is necessarily complete again, as fuses are wired in pairs, one in each lead, and it is quite possible that two may have collapsed together. Further examination may therefore be needed before the trouble is rectified.

After treatment, each fuse holder is pressed firmly into its socket again and when the repair is finished the box is closed and the power turned on. If all is well, every point will be in working order again.



OPENING AN IRONCLAD SWITCH AND FUSE BOX

REMOVING A FUSE HOLDER FROM A DISTRIBUTION BOX

INSERTING NEW FUSE WIRE

Fuse Holder cleared of old wire

Twisting new wire around first contact screw

Pulling the wire down the tunnel

Tightening up a contact screw

PLATE IV
Fuse Repairs

WIRING REPAIRS

The bayonet lampholder and adapter.—Sometimes the constant use of an iron or other portable item of equipment on an ordinary lampholder causes a wire to pull loose or break. Another defect which may arise is a stiff contact leg in the holder mechanism. To correct either fault, the lampholder has to be dismantled.

Before beginning, the power is turned off at the ordinary switch and, for the sake of safety, at the main as well. The lampholder is then taken to pieces by unscrewing. All holders are not alike in detail, but all have two set screws fixed in an insulated block by means of which the flexible wires are gripped. The flex ends, after being cleared of insulation for a short distance, are twisted, bent double and slipped into their holes. The set screws are tightened so that they grip the double part and the wiring is done. No bare wire should protrude from the fixing holes when the flex is gripped, nor should any odd strands have escaped the set screws.

A lampholder with a faulty spring leg causes the lamp to flicker or to operate erratically. The imperfection may usually be recognised at a glance because the end of the leg where it bears on the contact of the bulb is discoloured and burnt by the sparking which has occurred there. When the holder has been opened, it will be found that the springs may be released by unfastening the leg-holding nuts or bolts. If a spring is broken or has lost its tension, the holder is usually discarded, but if it has simply closed up owing to constant compression, it is pulled out again and returned to its place. When reassembled, the holder is likely to be perfectly sound.

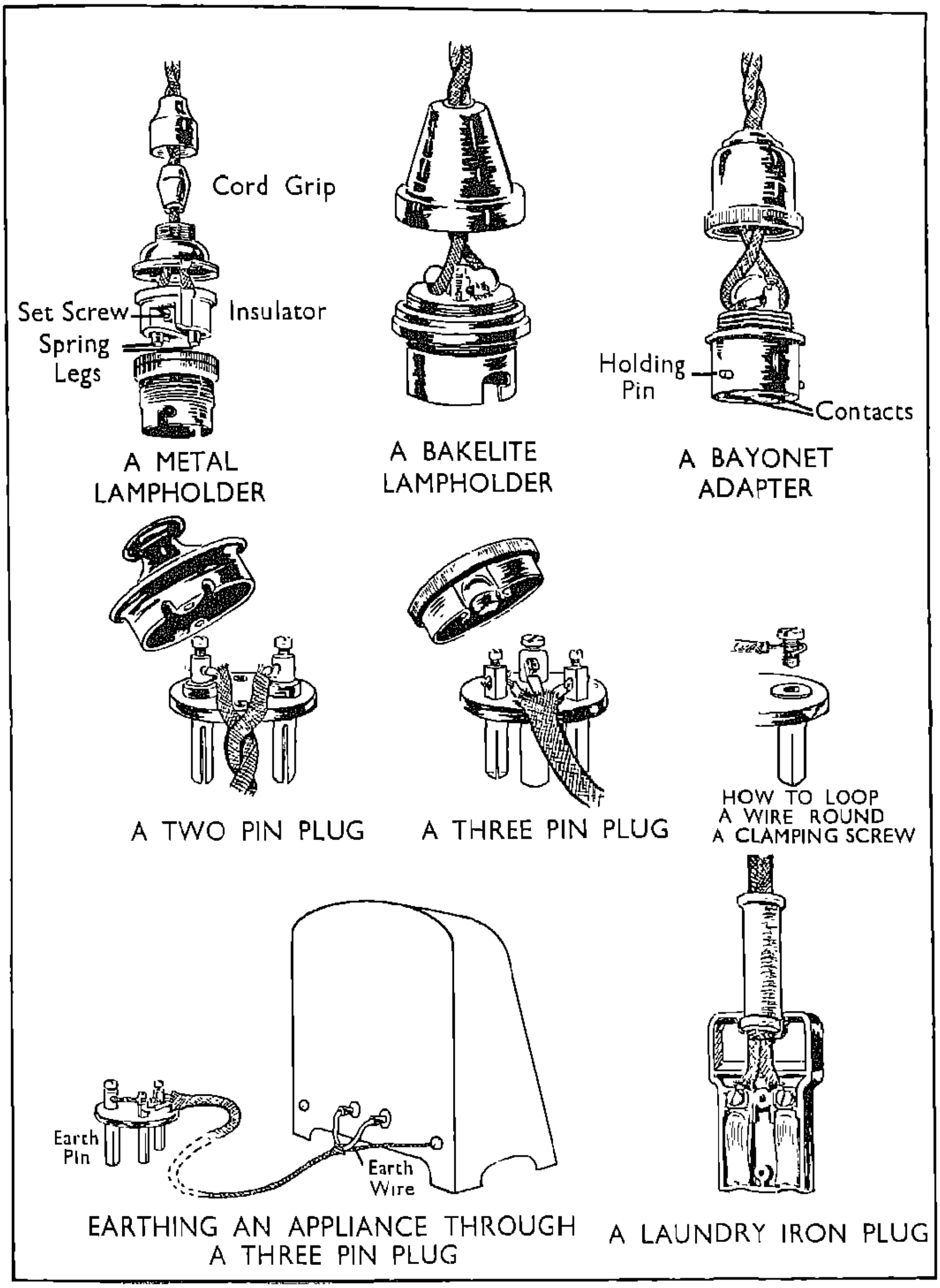
Two- and three-pin plugs.—Wiring plugs is similar to wiring a lampholder. If the wires have to be clamped under screw heads inside the plug, one point should be noted. The flexible wire, after being cleared of insulation and twisted, is looped round the screw in a clockwise direction so that it will tend to tighten as the clamp bears upon it. A wire looped in the opposite way is almost certain to slip out of place.

When properly wired, the thick peg on a three-pin plug acts as a guard against shock, for it is intended to be a means of earthing the metal case of the appliance in use. Three-core cable is fitted to three-pin plugs, and the distinctively coloured wire connected to the earth peg is attached at its other extremity to a fixing bolt on the metal case.

Cables.—Although most flexible cables have a very long life, the lead of an ordinary domestic laundry iron gives trouble comparatively frequently owing to the constant bending and turning which it has to stand. A break caused by constant bending occurs inside the rubber covering where it cannot be seen. Occasionally the broken ends may be held in contact by the rubber for a time and then pulled apart by a slight movement of the cord. The complaint usually associated with this sort of defect is that the iron doesn't seem to get as hot as it should. Unless aware of the tricks played by an internal break, the would-be repairer may be puzzled by the strange symptoms. The flaw is generally to be found near the plug which fits on the iron, and it may be detected by pulling gently at each wire in turn. The rubber stretches at the point where the breach occurs as there is nothing inside to give it strength. To effect a repair, the end of the cable is cut away at the break, new connecting portions are bared and the shortened flex is refixed in the plug.

The following points, applied when necessary, prevent or reduce cable ailments:

1. Trim and bind with thread all frayed ends on cotton insulation.
2. Use the cable clamps provided in well-made plugs.
3. Avoid kinking as far as possible.
4. Use cord enclosed in a single cotton binding rather than twisted flex when wiring portable equipment.
5. Bind with insulating tape any cotton binding which has suffered abrasion.



A METAL LAMPHOLDER

A BAKELITE LAMPHOLDER

A BAYONET ADAPTER

A TWO PIN PLUG

A THREE PIN PLUG

HOW TO LOOP A WIRE ROUND A CLAMPING SCREW

EARTHING AN APPLIANCE THROUGH A THREE PIN PLUG

A LAUNDRY IRON PLUG

PLATE V
WIRING REPAIRS

RADIO REPAIRS

When a wireless receiver fails to function in the usual way, it is likely that a slight adjustment is needed rather than a real repair. Testing and mending commercial sets offer little scope for the amateur but the correction of many of the trivial shortcomings can be undertaken by the owner. The following faultfinding chart includes most of the common causes of poor reception:

When no sounds are audible.

1. Switch on set or on mains supply OFF.
2. Aerial and earth wires not fastened to the set.
3. Batteries run down or disconnected.
4. Fuse blown.
5. Change-over switch in "Gramophone" position.
6. Valve loose in holder.
7. A valve or other component lead loose inside the set.
8. Defective mains plug or flex.

When sounds are audible—(a) Crackling noises.

1. Interference from some outside source.
2. Defective valve or valve holder.
3. Partial break in mains or other flex lead.
4. Loose terminal on battery or in receiver.
5. If crackling is heard when using a control knob—poor contact in the controlled component.

(*b*) *Signals weak but clear.*

1. Aerial or earth disconnected.
2. Power input wrongly adjusted.
3. Wire disconnected inside the set.
4. Defective valve or other component.

(*c*) *Signals distorted.*

1. Reaction control turned too far.
2. Batteries run down or incorrectly connected.
3. Overloaded valves or speaker due to excessive loudness.
4. Defective component.
5. Valves not in correct holders.

Accumulators.—Receivers operated by power from batteries usually make use of accumulators for low tension purposes. To obtain good service from these storage cells, their condition should be checked occasionally.

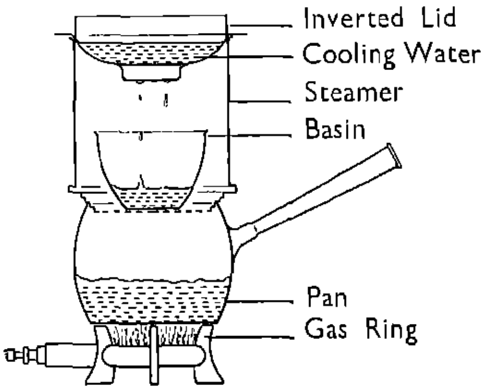
To prevent corrosion, the terminals of an accumulator should be kept coated with grease. Corroded terminals are not only inefficient electrically, but are also stiff and awkward to turn and unpleasant to touch.

Accumulators should never be stood near carpets or other valuable fabrics as a splash of the acid which they contain is able to rot such materials very quickly. If some of the liquid be spilt accidentally on clothes or furnishings, its effect should be neutralised immediately by applying washing or baking soda or household ammonia. The chemicals are removed afterwards by dabbing repeatedly with a damp cloth.

If the plates in a cell become dry they tend to disintegrate. To prevent this, the acid solution is always kept up to the prescribed level by adding distilled water to make good evaporation losses. Tap water is definitely not pure enough for this purpose, although clear rain water may be satisfactory. Distilled water is so easy to prepare, however, that there is no excuse for not using it, both for radio accumulators and the car battery.

Preparing distilled water.—A supply of distilled water can be produced quickly and economically with the aid of ordinary household utensils. A saucepan, partly filled with water and fitted with a steamer, is placed on a gas ring or hot plate. A basin of convenient size is lowered into the steamer and the lid is put on, the wrong way up. The depression in the inverted lid is filled with cold water, and the apparatus is ready for action.

The steam from the boiling water in the pan passes into the steamer through the holes in the base and condenses on the lid and its handle as these are kept cool by the water above them. The distilled drops which form on the underneath side of the lid fall into the basin below. The cooling water is replaced from time to time as it becomes hot, and the heating of the pan is continued until sufficient distilled water has collected in the basin.



SIMPLE WATER DISTILLATION APPARATUS

TOPPING-UP AN ACCUMULATOR WITH DISTILLED WATER

SETTING UP THE DISTILLATION APPARATUS

PLATE VI
Radio Repairs

WINDOW FRAMES

Lubrication.—There is no surer way of securing satisfactory window action than by applying a small quantity of suitable lubricant regularly to moving parts. All hinges, catches, pivots and sash cord pulleys should have a drop or two of ordinary machine oil applied to them with a small brush. A touch of black lead or even lard on the sliding surfaces of sash windows reduces wear and jamming. Too much lubricant makes a mess, but none at all will be followed inevitably by strain or fracture.

Replacing sash cords.—This is a very awkward job to carry out, although there is nothing really difficult about it. As glazed frames of some value have to be handled, it is really necessary to have the services of an assistant when dismantling and reassembling. Tools and materials should be set out beforehand in an orderly fashion, and special care must be taken not to drop anything from windows overlooking a thoroughfare.

The window is in two parts. The lower section can usually be repaired without disturbing the other, but the top frame can be reached only after removing its fellow from the window case. There is a wooden beading on the inside of the window which holds the frame in position. This is carefully levered off the main woodwork. A second strip separates the two portions of the window, and this is taken out of its groove if the top frame is the one which is needing attention. Very often the beading is held firmly in place by many coats of paint, and in such cases it may be necessary to break the wood away and make new replacements.

When the first retaining strips are out of the way, the lower frame may be drawn forward into the room. If both its cords are broken the frame will be quite free, but if one still holds, then the frame will have to be supported by the assistant unless, of course, it is proposed to replace the pair.

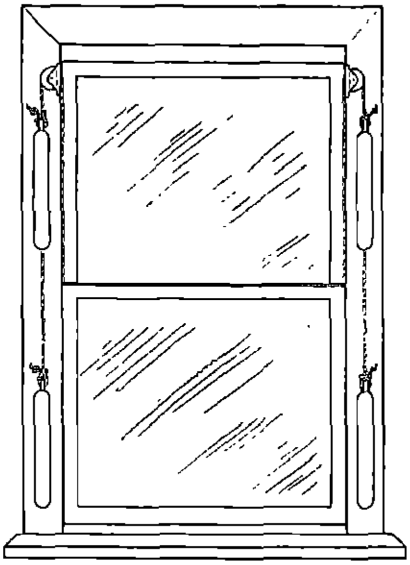
The old cord ends are fastened into grooves in the frame sides by means of nails. These are removed with a suitable gripping tool so that the grooves are ready for the new cord. The frame is now put on one side whilst the work on the window case is done.

The balance weights are reached through small trap doors in the frame sides. The traps are held by a screw or two, but may be difficult to move owing to the paint on the edges, although careful manipulation with a lever should be effective in overcoming the obstruction. When the way is open, each balance weight is cleared of old cord.

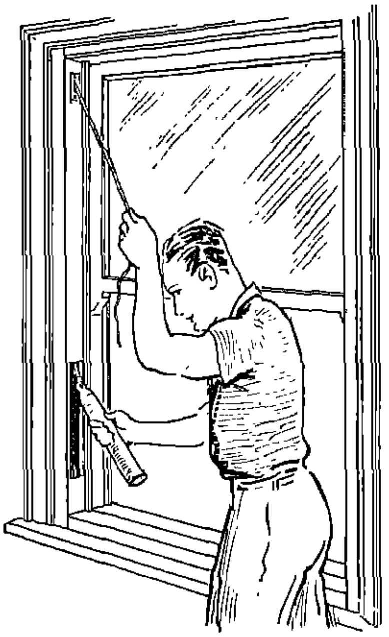
When the pulleys have been oiled and brought into good working condition, the new cords are threaded over them and pushed down inside the window case. If there is difficulty in getting a cord through, a string weighted with lead may be passed over the pulley first, and when the weight can be reached through the trap the string can be used to pull the sash cord through. Sash cord is obtainable at hardware stores, and it is sound practice to buy good quality. The cord may be rubbed with hot linseed oil before being installed, and further dressings of this preservative from time to time have a beneficial effect.

The cords are knotted to the weights which are then replaced in the case, the running of each pulley is tested by drawing its weight up, and then the cords are cut off to the right length. Each cord has a knot tied at its free end to prevent it slipping over the pulley. When the pair of cords is in position and working well, the trap doors are refitted and attention is turned to the sliding window frame.

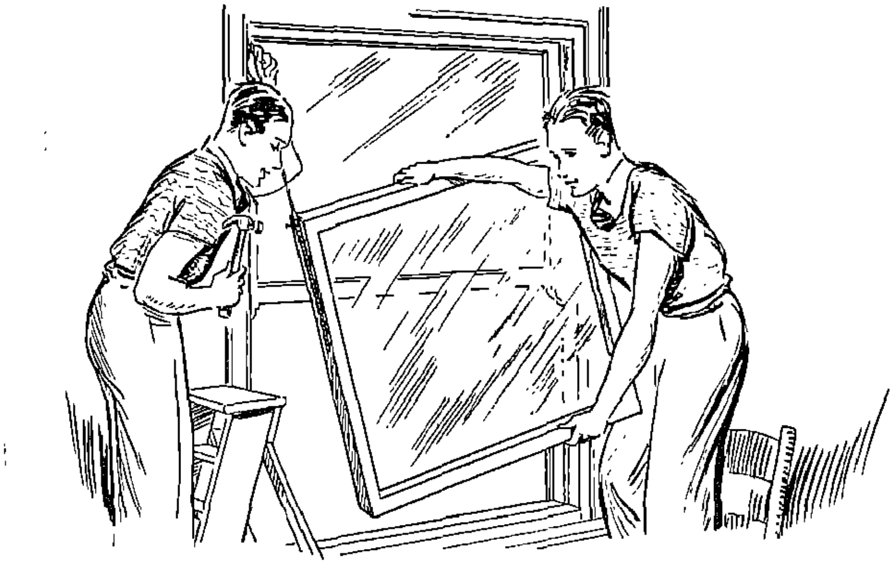
With the assistant holding up the window frame, one cord is unknotted and pressed into its place in the side. The free end is fastened down with a large-headed nail. This fixing is repeated at the other side and then the running of the frame in the case is tested. If everything works smoothly and correctly, an extra nail or two is hammered into the cord and frame at each side, the beadings belonging to the window case are replaced and the repair is finished.



SASH WINDOWS, PULLEYS, CORDS AND BALANCE WEIGHTS



INSERTING A BALANCE WEIGHT IN THE WINDOW CASE



FASTENING A SASH CORD TO THE WINDOW FRAME

PLATE VII

Window Frames

DOOR LOCKS AND CATCHES

When installed in positions where they are protected from bad weather, locks and catches may operate perfectly for years without attention of any kind, but such service is not usual in cases where mechanism is subjected to damp air or rain. Increasing stiffness in operation is usually the first sign of breakdown and is due to lack of lubricant or to internal rusting, but a sudden and complete failure of the appliance may occur at any time as a result of a fractured spring. Routine repairs in connection with locks and catches are concerned with cleaning, greasing and spring replacement.

There are many varieties of door fastener and each has its own peculiarities. The ones illustrated here are chosen for their simplicity. Some fasteners combine a catch and lock in one case, but others contain one of these units only. Some rely on a single spring to work both the catch and the lock, but others incorporate separate ones. Some lock springs are spiral, others are straight, but the most common kinds are shaped like a letter 'V.'

How the door catch works.—Inside the catch case on the square knob shaft there is a double ended lever which bears on two projecting parts of the spring-loaded bolt. When the knob is turned in either direction, one of the lever ends presses back the bolt and compresses the spring. The bolt is returned to its place by the spring when the knob is released.

How the door lock works.—In a lock, the key is the lever which pushes the bolt unit backwards or forwards. There is, of course, no spring return action of the bolt in this case. In the path of the turning key there are projections which correspond with the cut-away shape of the lever part, so that only a key of the correct shape will fit. In addition to the bolt itself, a lock contains a spring-controlled tumbler which bears on the bolt and is worked by the key.

As the key turns, it first lifts the tumbler until its stud is clear of the rectangular notch and then it catches in the bolt which is now free to move. When the bolt has moved the required distance, the key releases the tumbler which springs down into the second notch on the bolt.

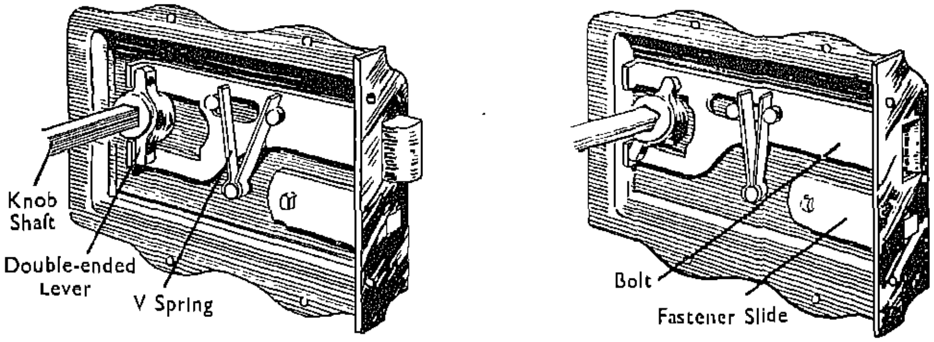
Repairing a lock or catch.—The mechanism of a door fastener is fitted in a metal case which has a detachable side, held in position by one or two set screws. This loose plate can be removed when the lock or catch has been taken off the door, and then the various working parts can be cleaned and greased.

If a spring is broken, the pieces will be found lying loose somewhere inside the case. These pieces should be preserved as they form a sample to show to the ironmonger who is to supply a replacement.

After reassembling the parts, the action of the fastener can be tested before refixing the cover plate. If everything works smoothly and easily, the plate is screwed on and the test is repeated. Sometimes the plate fouls the mechanism when held down very tightly, and it may therefore be necessary to release the screws a little. When in proper working order the case is fastened in its original position.

Door knobs.—When effecting a replacement or when repairing the catch, it is necessary to remove a door knob and its shaft. Some knobs are a slip fit on their square shafts but others are screwed into position. With both kinds it is common practice to use a grub screw as the fixing agent.

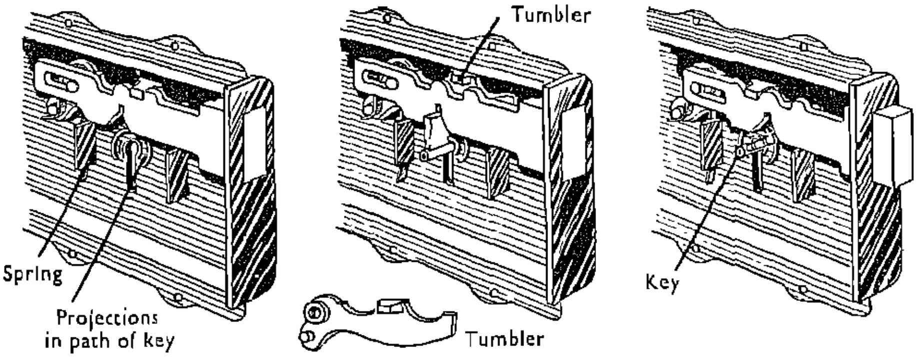
When dismantling, one grub screw is taken out and its knob is then either slipped or screwed off. There is no need to interfere with the other knob as the shaft can be extracted from the catch with this still in position. Provision for adjustment when reassembling is made on both plain and screwed shafts. In the former, a whole series of grub screw holes is drilled and tapped. By selecting suitably from these, and using a packing washer on the shaft if necessary, a good fit can be attained. On the threaded shafts, the knob is screwed to the best position and then locked with the grub screw which fits in one of the flutes on the shaft.



IN NORMAL POSITION

WITH BOLT DRAWN BACK

A SIMPLE DOOR CATCH

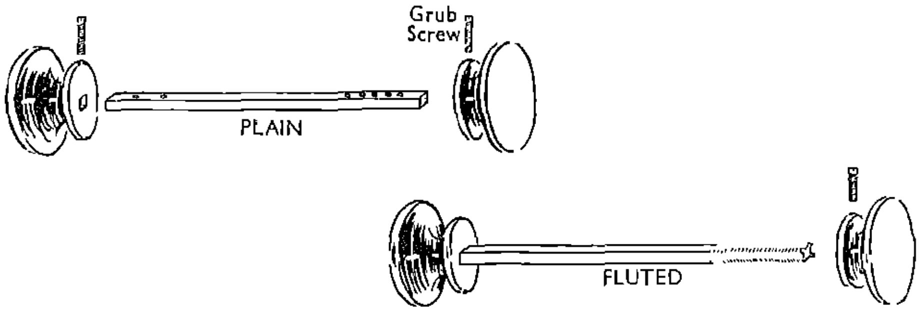


IN NORMAL POSITION

WITH TUMBLER RAISED

IN LOCKED POSITION

A SIMPLE DOOR LOCK



KNOBS AND SHAFTS

PLATE VIII

Door Locks and Catches

WALL PLUGS

Types of plug.—In house construction and similar work, joiners make use of the wooden plug with completely satisfactory results. In a plastered and decorated house, however, large wood plugs are not a very attractive proposition as they can be fitted only by disturbing quite a large patch of wall. The householder is justified in raising objections to the use of plugs which leave an unsightly area of broken paper or scratched paint around each screw. For outside work or for internal unplastered walls, the amateur may use the wood plug with confidence.

As alternatives to wood plugs there are soft metal and fibre plugs. These are available in many sizes to suit the standard range of screws, and they are particularly well adapted to meet the requirements of the average domestic repair job.

Plugging with wood.—With the aid of a wooden plug it is possible to make an excellent cheap fixing in a joint in a brick or stone wall. Rectangular plugs between bricks are commonly used, but cylindrical plugs fitted in the 'T' junction of the mortar are quite a practical proposition.

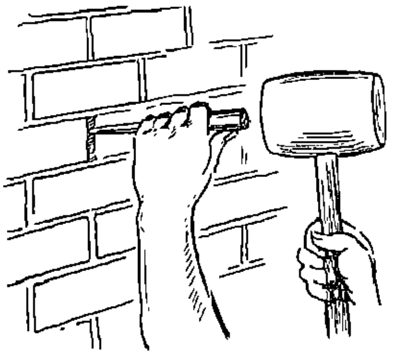
At the place where the screw is to be fixed, the mortar is cut away by means of a chisel so as to leave a clean straight-sided slot. A piece of sound, straight grained timber is then shaped to dimensions rather greater than the hole so that it may be a good driving fit. It is not cut off to the correct length at this preliminary stage. The oversize allowances must be reasonable as the wood is to be driven home without splaying out at the end and without having its surface scraped away by the brickwork. When the plug is nearly home, it is cut off as close to the wall surface as possible by means of an ordinary hand saw. A final blow or two from the mallet brings the wood flush with the surrounding brickwork. The fixing screw may then be driven into position.

Metal and fibre plugs.—The success of a small plug fixing depends almost entirely on the cutting of the plug hole, for the gripping surface of the plug is small and so it is very important that the hole shall fit the plug. At first glance this may appear to be expressed the wrong way round, but this is not so, for the workman can determine the size of the hole, though he has to accept the plug sizes fixed by the makers. The special drilling tools sold for use with plugs are made in the right sizes, but even then with a crumbly medium such as plaster it is very easy to make the hole too big.

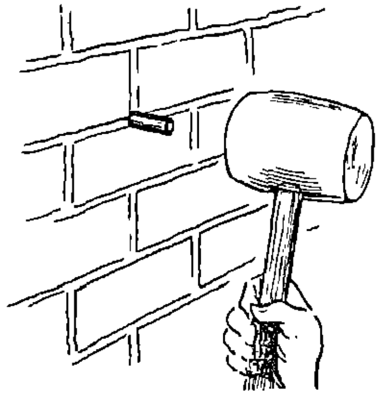
Far more important than the actual tool used for drilling are the discretion, care and judgment applied to the manipulation of it. For most purposes, a twist drill held in a joiner's brace is very satisfactory, although the instruments supplied with plug outfits are excellent. Common sense needs to be applied to the selecting of a drilling implement for a particular job. It is obvious, for instance, that a twist and not a jumping drill will be used on brittle materials like slate, but that either type may be effective with stuff like brick or concrete. A very sound drilling rule is to drill very slowly when using a twist bit, and to strike lightly when using a jumping bit.

There are special points to watch when drilling a tile. The twist drill should be sharp and it should be applied firmly to the glazed surface. The point should be lubricated with a drop of turpentine until the glaze has been penetrated. The pressure applied to a tile must never be heavy enough to cause drag as the material is very prone to crack suddenly. A little practice on an old tile is worth while, especially if the work in hand is concerned with an expensive tiled surface.

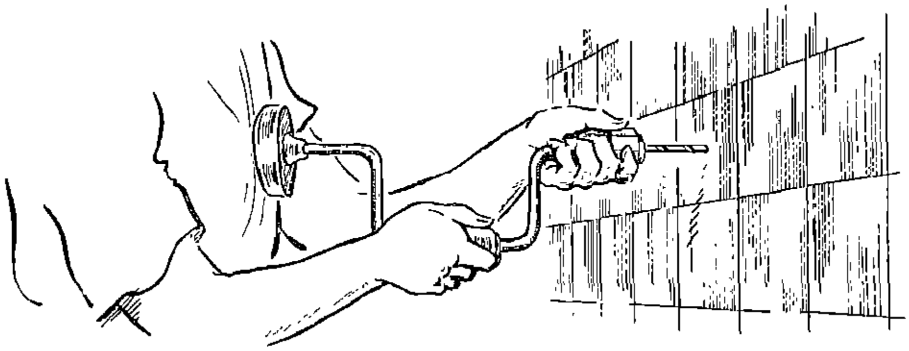
The depth of a plug hole should be rather greater than the length of screw which the wall has to take, and the plug should fill the hole completely. Both metal and fibre plugs can be trimmed to any required length quite easily with a pocket knife. As the screw cuts its way into the small open core of the plug, it expands the fibre or metal and makes it grip the internal surface of the hole.



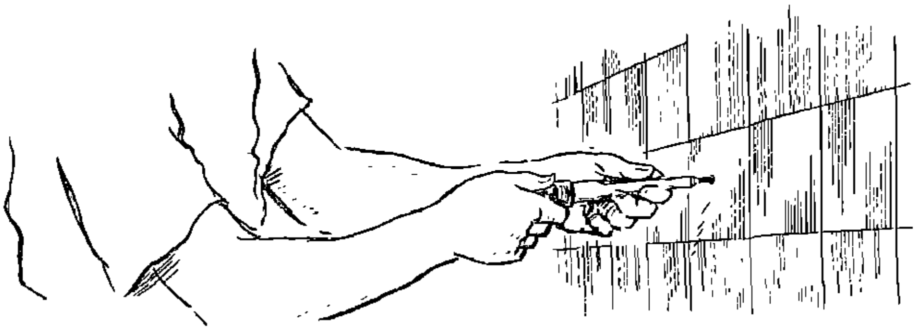
CUTTING A PLUG HOLE
IN A BRICK WALL



DRIVING A CYLINDRICAL PLUG
INTO A BRICK WALL T JUNCTION



DRILLING A SMALL PLUG HOLE



DRIVING A SCREW INTO A SMALL PLUG

PLATE IX
Wall Plugs

FROZEN PIPES

Not only is it inconvenient to have the water supply of a house cut off by frozen pipes, but there is also a very real chance of bursts because water expands as it freezes and may demand more space than the containing pipe can give without fracture. Once ice has formed in a pipe nothing can be done to avoid the consequences, although there are precautions which might have prevented the occurrence and also ways and means of minimising its after effects.

Precautionary measures.—There are three ways by which bursts may be avoided: (1) the water in the pipes may be kept at a temperature above freezing point; (2) the pipes may be made so that they yield to the expanding water without bursting, or (3) the water may be drained out of the pipes before freezing can occur.

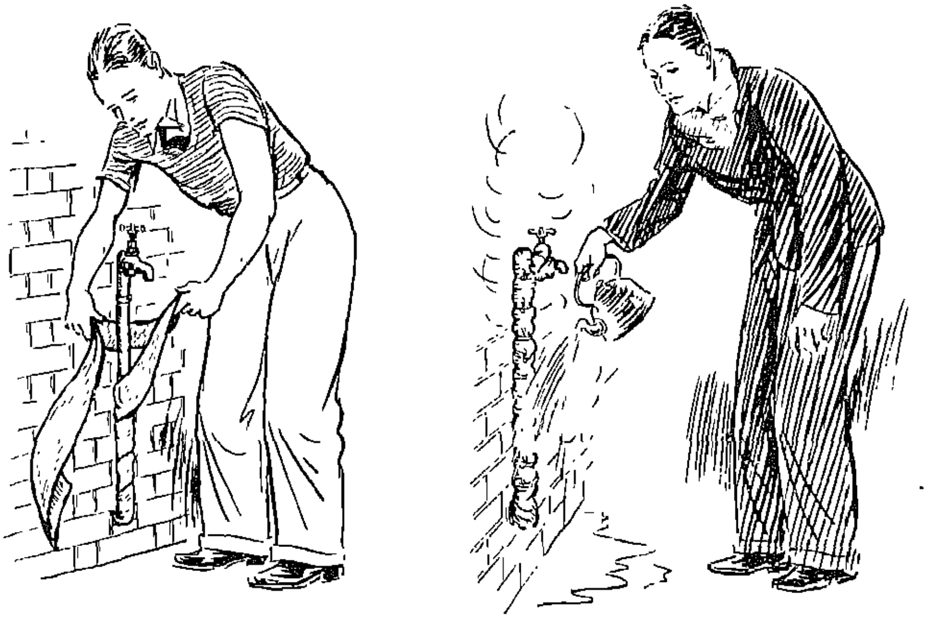
In order to make a quantity of water freeze, a good deal of heat has to be extracted from it by its cold surroundings, and the process can be made very slow by wrapping the water container with material of low thermal conductivity. The principle may advantageously be applied to all water pipes situated in outbuildings or in inadequately heated parts of the house, such as cellars and the space just below the roof, as it forms the basis of an excellent guard against a frost of short duration. All the exposed pipe is enclosed within the fabric, which is held in place by strings tied at intervals of a few inches. Long broad strips cut from an old carpet underfelt are ideal for the job, but blanket, cloth, straw and even newspaper are good alternatives. A simple wooden case arranged so as to enclose the binding will not only improve the appearance but will also provide additional heat insulation.

Now wrapped pipes cannot withstand continuous frost, as the poor conducting layer cannot interrupt the process of cooling completely. It is wise, therefore, during frosty weather, occasionally to run the taps connected to lagged pipes and thus to bring in fresh water from the mains. This will be rather warmer than that which has been standing in the pipe, and so freezing will be delayed. During an unusually cold spell, anxiety may be allayed by working an oil stove or other portable heater near the pipes for a short time each day, but as a rule the risk of bursts is not sufficient to justify such expensive and inconvenient measures.

The geometrical figure with the biggest area for a given perimeter is the circle. Therefore freezing water in a cylindrical pipe can find space for expansion either by stretching the metallic wall or by bursting it—a simple change of shape cannot give any additional space. But if the pipe in its normal state has an oval instead of a circular section, then freezing will simply tend to modify the shape without straining the metal at all. A simple treatment for application in the home makes use of this idea. The lead pipes which are exposed to freezing conditions are tapped gently with a hammer along the whole of their length so that their shape becomes oval instead of round. This modification, of course, does not affect the risk of ice formation, but it reduces materially the chance of bursts due to expansion. Lest the cure be worse than the disease, the tapping must be carried out with discretion!

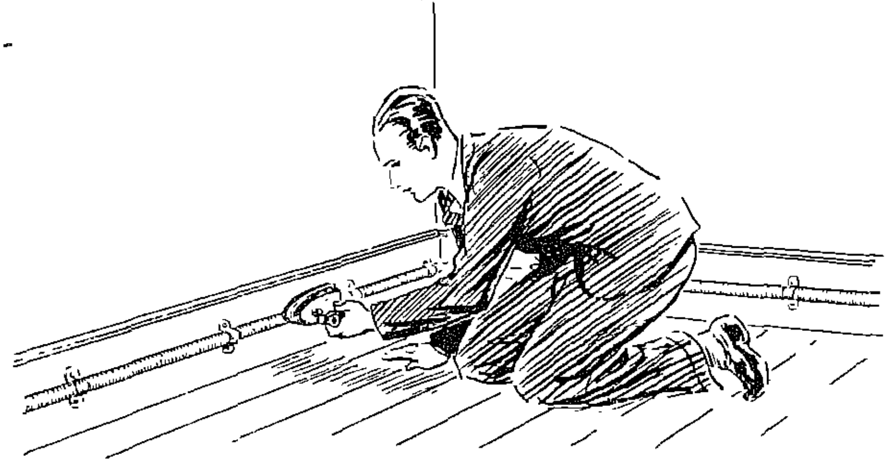
The most reliable way of avoiding bursts is to turn off the water supply by means of the main tap and then to drain all the pipes and cisterns in the house. To carry out this performance regularly is very irksome, but it is a plan well worth putting into practice when leaving home for any length of time during the winter months.

Thawing pipes.—The belief that thawing a pipe may cause a burst is without foundation. If the pipe is going to show damage, the burst will already have occurred—thawing may start a leak, but it cannot cause the burst. For the convenience of the occupants of the home and in order to prevent further ice formation, it is wise to thaw frozen pipes by artificial means as soon as possible.



WRAPPING AN EXPOSED WATER PIPE

THAWING A FROZEN PIPE WITH HOT WATER



THAWING A FROZEN PIPE INDOORS WITH A LAUNDRY IRON

PLATE X

Frozen Pipes

The most common, and at the same time the most easily remedied, kind of frozen pipe is the waste outlet of a sink, bath or wash basin. A handful of salt, followed by very hot water, can usually be relied on to clear the obstruction.

Pipes connected to the water supply cannot be thawed by chemical means in this way and have to be subjected to heat from some external artificial source. The best, though not the quickest, course to adopt is to put a heater such as a stove or an electric fire or toaster in the room near the frozen section. Alternatively, provided that the source of trouble is in a place where water can be used freely, the pipe may be warmed by rags soaked in boiling water or by pouring directly from a kettle. By leaving the tap open, the progress being made can be judged whilst working on the ice-bound portion of the installation.

In parts of the house where hot water bandages are out of the question, a hot laundry iron may be used. The tap connected to the frozen length of pipe is turned on and the iron is then moved slowly along from one end to the other, the movement being repeated many times until the water course is clear. Obviously, the iron should not be held in one place for a long time, nor should it be unreasonably hot.

Freezing frequently occurs in and near a cistern connected to the hot water system and fitted in the roof of a house. When the surface water in the tank freezes, it hold the ball tap in the closed position. Consequently the water in the tap itself and in the few feet of exposed pipe is undisturbed. Formation of ice is thereby encouraged. After a short time the hot water taps fail and the action of the cistern has to be re-established before the system will work again. After breaking the ice, the ball tap is released by thawing either with hot water bandages or with a hot iron, and then the application of heat is continued along the supply pipe until the circulation is restored.

The water in the pipes of a hot water system which is in constant use is not likely to freeze, but such an event may occur in a home which has had no fires in it for a day or two. Under no circumstances should a fire be lit in the grate to which the boiler is fitted, until the pipes are thawed and the circulation is completely re-established. Failure to observe this precaution may be followed by steam accumulation in the boiler and consequent explosion.

When a burst does occur.—This emergency has to be dealt with very quickly if the burst is a serious one, or the result will be extensive flooding. If the leak is a manageable one, a bucket may be used to catch the water whilst the main supply tap is being turned off and the pipe is being drained through one or two of the ordinary taps. A big burst may be out of control, but the damage can be reduced to a minimum by promptly operating the main tap. Another useful plan, applicable to lead pipes, is to hammer the part near the burst *on the supply side* until the flattening cuts off the flow. Although crude, this treatment can be very valuable in a crisis.

A burst pipe needs the attention of a plumber, but very satisfactory temporary repairs can be made without professional assistance in cases where the leak is only slight. With the main supply off, the pipe near the crack is cleaned and dried. Then a layer of some soft sealing material such as putty, plastic wood, moist plaster or soap is applied to the pipe and worked in with the fingers. After allowing the material a little time to dry, the pipe is bandaged with a strip of cotton rag which in turn is enclosed by a tight wrapping of insulating tape.

THE FOUNDATIONS OF DRAWING

This interesting and informative Article will be read with appreciation and profit by those Teachers who are not quite sure how to deal with the Creative and Imaginative side of Drawing.

Taken in conjunction with the article on BEAUTY IN THE HOME, it will prove a valuable source of inspiration for many unusual and fascinating activities in connection with School Projects.

The Article is additional to that on THE TEACHING OF DRAWING in Volume V.

PLATE I. HOW WE SEE—I

We see the world in colour, dark colours against light colours, and light against dark. It is a series of pictures whose colours are changing all the time. In the faint light of dawn we see delicate greys and blues and greens. When the sun has risen we see strong light and dark colours. These fade again to blues and grey-greens when the sun is going down. At night when there is no moon it may be "pitch dark" and we cannot see anything.

As a rule a colour does not change merely from light to dark or dark to light. By looking at similarly coloured objects to those drawn in Plate I, yellow in the direct light will appear more white, the part in the shade will appear more green. Red looks more orange in light and more purple in shade. Green is more yellow in light and more blue in shade. Blue usually appears more white in light and darker in shade.

Striking effects can be seen when a coloured object reflects its coloured light on some near object. The following example illustrates this point. A man was standing by a light green door. The sun was shining directly on the door and the green light from it was reflected into the shaded side of the man's bronzed face. The whole picture was vibrating with a mixture of coloured lights.

The effects of autumn are some of the most arresting. Sometimes the change in the nature of the leaves is rapid and the heavy greens seem to change suddenly to light yellows, rich browns, vivid greens and orange reds. All things reflect different colours as their nature changes—old furniture and old glass are good examples of this.

When colours are side by side they change each other, just as people change when they come into contact with other people. Colours which are most unlike seem to make each other glow beyond their natural strength. Yellow and blue appear to make each other more vivid in colour and in tone. Those which are more alike seem to move further apart and frequently make each other appear more dull.

The Impressionists, who did most of their work in the open, were the group of painters who thought about and revelled in the exquisite colours which they saw. Colour in nature was their chief interest, just as home life was the chief interest of the Dutch painters and religion that of the painters of the early part of the Italian Renaissance.

In the country the attention is attracted continually to colour. In town we have to find objects which will give simple good effects of colour—yellow lemons; a large blue jug; green apples; red tomatoes. Folds of coloured paper—normal red, orange, yellow, green, blue and violet, placed where they will get the sun or a bright light on one side—will give some rich effects and show the changes of colour in light and shade.

If colours are rightly named they are defined and fall into their proper relation with other colours. There are six distinct hues—red, orange, yellow, green, blue, violet. Yellow-green is a colour—its family, or line, is green; similarly with other colours.

On a sunny day if a large sheet of coloured paper is held so that the light is reflected into the shaded side of a child's face, a striking effect is given.

Effects of colours on each other are seen clearly when large areas of bright colour come together in painting and in handwork. Once the attention is arrested, colour can be a means of intelligent contact with the material world and of the greatest practical value in everyday life.

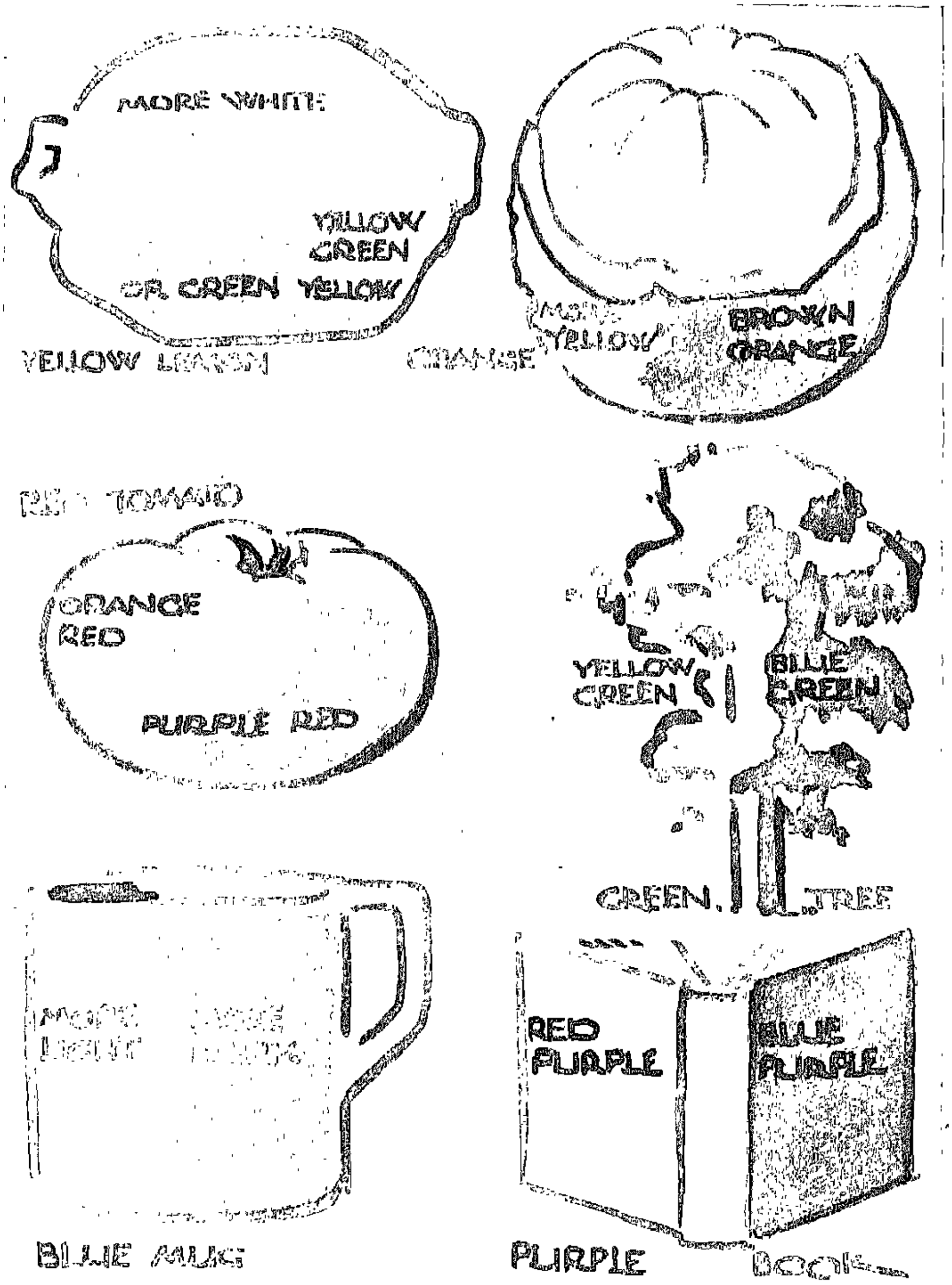


PLATE I

How We See

Colours undergo many changes due to the intensity of the light which is thrown on them, or to the proximity of a different colour.

PLATE II. HOW WE SEE—2

Once, I asked a boy of about four years of age why he had drawn a particular figure so small, and he said immediately, "It is a long way away." He had realised a little how we see things and had expressed it in his drawing.

Plate II shows a boy standing at one end of a long room looking down it. All the lines on the ground are parallel to each other and going away from the picture at right angles. They appear to slope up, to converge, and if continued to meet at a point opposite him on his eye level. The other lines below his eye—the top of the fireplace, the arm of the chair, the window seats—are parallel to the lines on the ground and if continued would appear to meet at the same point, which is his centre of vision. The lines of the ceiling—the top of the door on the left, and the top of the windows—are parallel to each other and to the ground and go away at right angles. They appear to slope downwards, to converge, and if produced to meet also at the centre of vision.

Below is a drawing of cottages on flat ground and a river. The chief lines in it are on, or parallel to, the ground. They are going away but not at right angles.

The two drawings show:—

1. Lines which are parallel to each other and to the horizontal plane and which are going away from the picture appear to converge and meet on the eye level. If they are going away at right angles they meet at the centre of vision.

2. Lines which are parallel to the horizontal plane, going away from the spectator and which are below the eye, appear to slope up and vanish at a point on the horizon.

3. Lines which are parallel to the horizontal plane, going away from the spectator and which are above the eye, appear to slope down and vanish at a point on the horizon.

In the room there is a circular electric light shade. It is above the boy's eye and some distance in front of him. He can see under it and it appears as an ellipse. There is to the left a circular table in front of him. He can see on top of that, which appears also as an ellipse. If he held this small table so that the circular surface came level with his eye, it would appear as a straight line.

The curved banks of the stream in front of the cottages are equidistant and they wind along level ground. The curves appear flat, and the banks appear nearer together as they go farther away and finally vanish at a point on the horizon.

By looking at similar objects and holding a pencil along the lines or against them, the slope is seen easily.

The Italian painter of the Early Renaissance, Uccello, was the first to give a great deal of thought to the way in which lines appear to run when seen in perspective. It is said that he became so intrigued with the study that he sat up far into the night working at problems saying, "How sweet a thing is perspective." In his battle piece in the National Gallery, the little men and the swords lying about in queer foreshortened positions show how absorbed he was in it. The picture is a beautiful decorative panel, but the delightful wooden figures of horses and men make it clear that he was thinking, as he worked, about perspective and design, certainly not about the noise and movement of battle.

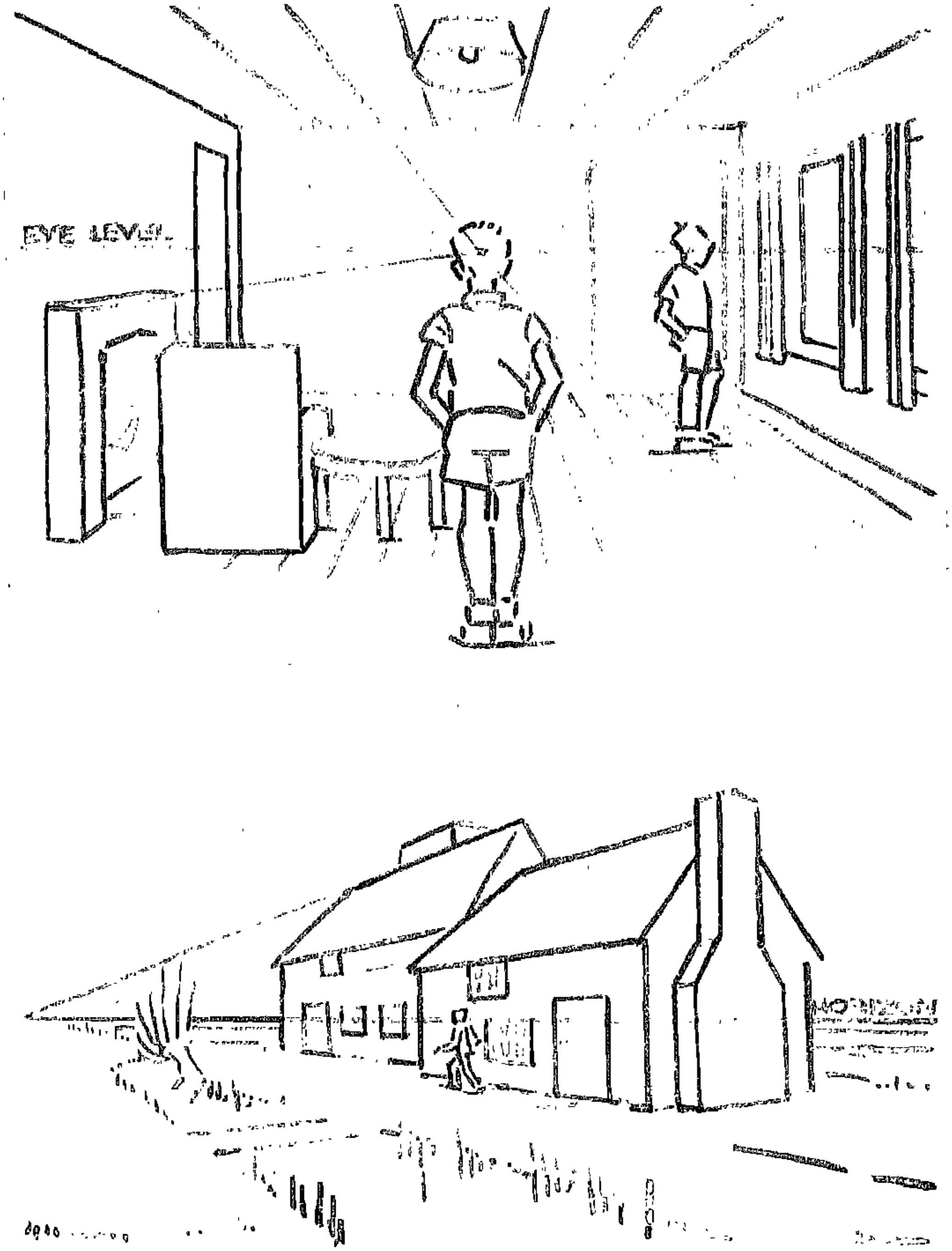


PLATE II

How We See

These two pictures illustrate the importance of perspective and proportion. The eye level, the centre of vision, and the horizon are taken as the basic lines on which to build up the perspective of the whole.

PLATE III. HOW WE SEE—3

The drawings on Plate III show some objects in unusual perspective—a boy lying on the ground feet first, a chair from above, a duck from above, a dog looking out of a window from immediately below. They arrest attention because the points of view are less usual than those of Plate II.

Generally, things are drawn from points of view which show their structure, their characteristic appearance, and their position. The lines and, if necessary, the colours or tones are copied as they appear with the intention of describing or reproducing the *object as realistically as possible.*

Since the 13th century at least painters have been trying to express realism, but that is only one way of working.

At the present time many children are given materials, shown how they are used and then encouraged to express themselves freely, without being bothered with theories and ways of working. A great deal of most interesting work is being done, but some people are uncertain about it, because they do not understand it.

The way in which a subject is worked out should depend upon the subject. A child who is interested in the structure of animals, or cars, or boats, presumably will want to make drawings which explain his special interests, which will suggest the relative proportions and give a good impression of the general appearance of the objects. For his purpose he will try to make careful descriptive drawings, and certain principles of perspective will help him. In nature study, too, perspective drawings are wanted quite as often as scientific drawings.

But the structure of an animal and the story of an animal are different things. To draw the story of a dog one has to be thinking all the time—what is that dog doing? To be called back from that to consider—is the structure right?—are the lines as they would appear?—is to break the sequence and take the life out of the picture. It seems impossible to express the vitality of a jumping horse yet make a drawing which shows its perfect structure at the same time. The horse would not be entirely without structure—that would make the drawing meaningless. There would be sufficient structure for the purpose.

If a child is expected to draw continually *from the kind of object which shows most* clearly how lines appear, he is working at a theory for its own sake. It is quite another matter if he knows how to make use of certain simple principles, to make the drawings of things which are of real interest to him rather more clear and useful. Continual copying, even from interesting objects, is confusing because it is a way of working for one purpose only. It is possible to be such a slave to reproductive drawing that it is impossible to become free again. Reproductive drawing has a great and useful purpose, but it is not considered the highest form of drawing. Certainly it is most laborious and very often entirely lacking in vitality. It does not seem natural for a child to do more of it than is necessary to help him in his purpose; and even then with the knowledge that the spirit of a thing matters far more than the letter.

To encourage original thought in this direction, teachers might ask pupils to make a collection of sketches of common objects drawn from unusual angles. The children could then exchange books, and try to guess what are the objects drawn by the other pupils.

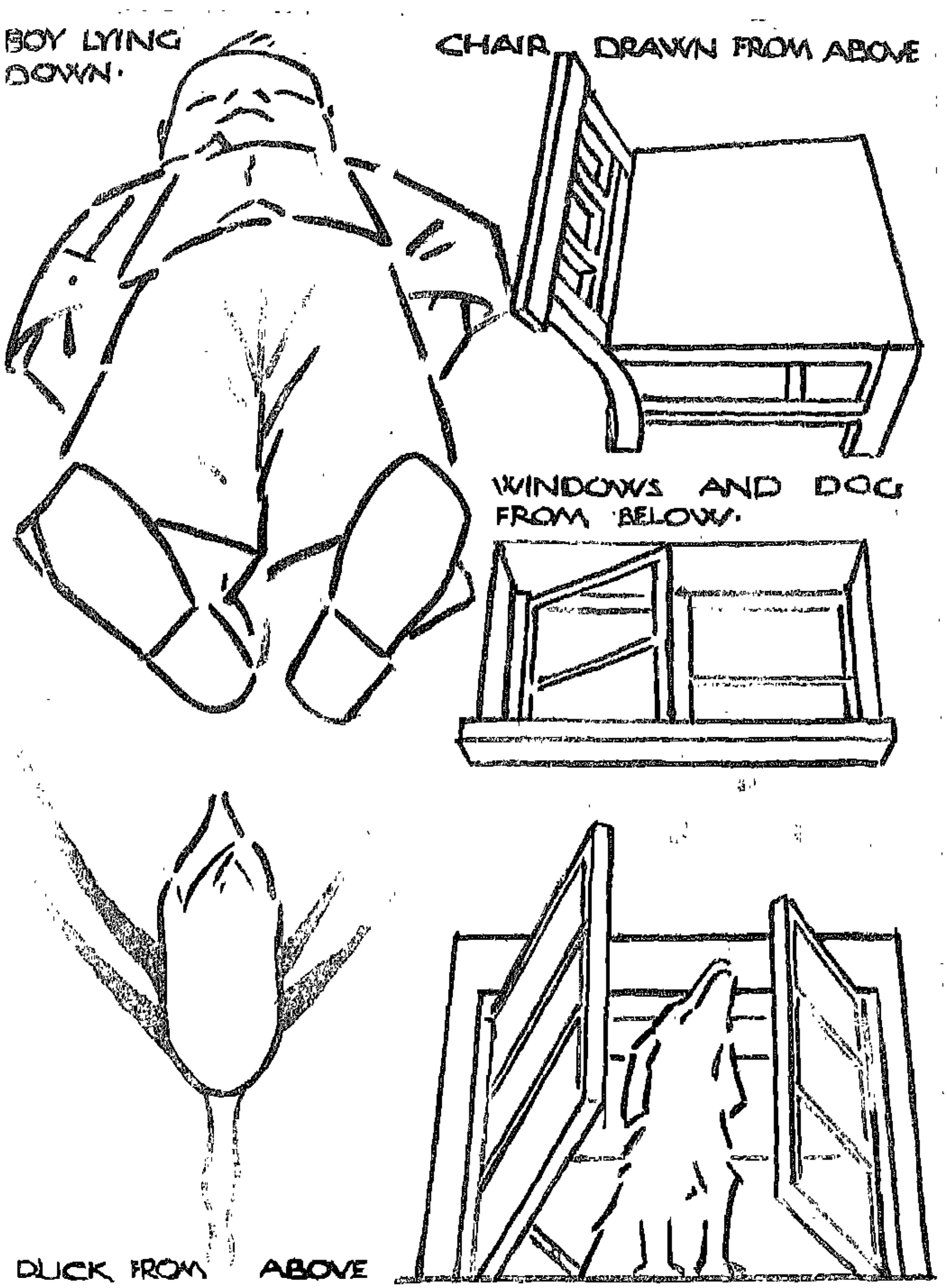


PLATE III

How We See

This Plate illustrates the interesting effect obtained by drawing common objects from an unusual angle. This is an excellent way of encouraging original thought and at the same time affords endless opportunities for individual and vital work.

PLATE IV. LIGHT AND SHADE

The top sketch on Plate IV shows a hay stack, distant fields, hedges and trees. It is an effect in tones of grey of a misty light. The faint colour has been ignored and the tones have been copied as they appeared, chiefly in silhouette.

The lower sketch is of similar objects, but in a strong light. The colour of the dark side of the stack appeared darker at the near edge and graded lighter as it receded. Most of the colours appeared to grade from dark to light or from light to dark. In this, the form of the objects has been expressed. It could have been done by copying the tones as they appeared, but the gradations were ignored and the tones run on flat.

If black and white drawing only is done and colour is ignored too much—especially in copying the tones of cubes, cylinders, and other similar dull objects—sensations of colour are not interpreted, and the sense of colour remains more or less undeveloped. Children who draw in this way often do not understand what they are trying to do, or how to make use of the principle of light and shade in a simple way.

Indiscriminate shading leads to many difficulties. If the principle is not understood shading has not much meaning; and if the pencil or pen is wrongly used or the wash badly run on, the drawing is extremely unattractive. Notebooks are very often spoilt in this way. Notebook drawings should be clear, descriptive, and more or less diagrammatic. Simply drawn perspectives amplify the plans and elevations and show the structure and form sufficiently clearly. Washes of colour are often helpful and necessary, but even good pictorial explanations of form are rarely, if ever, suitable.

Before working in light and shade it is as well to know how to run on a flat and a graded wash, and how to make a flat and a graded tone in chalk, pencil and pen, as well as to realise what is really being done. Wash seems to give a more lovely quality of shade than pencil or pen, and it is the quality of the tones which gives a drawing in light and shade a pleasant value. Contrast, the essence of light and shade, is seen perhaps most clearly and delightfully in drawings in silhouette. People, animals and birds are good subjects. The shape is so clearly and simply seen that it arouses the desire to make attractive balanced shapes and to arrange them well.

Effects of light in mist, in twilight, in rain, in lamp or candle light, make fascinating subjects; but they are so lovely in their effects of colour, that even while thinking about them, the cold black and white seems to take the life out of them. If, occasionally, the form of objects is suggested slightly in rapid life sketches, it seems to allow a greater freedom in drawing and to be helpful. Sketches, measured drawings of buildings and drawings for woodwork can be considerably helped by shade which explains the form and the relationship of the forms to each other. If a boy is interested in the old buildings in his town or village and can use the principle in a simple way to help him to understand form generally and architectural form especially, he is using the principle to help him to think and to express himself more clearly.

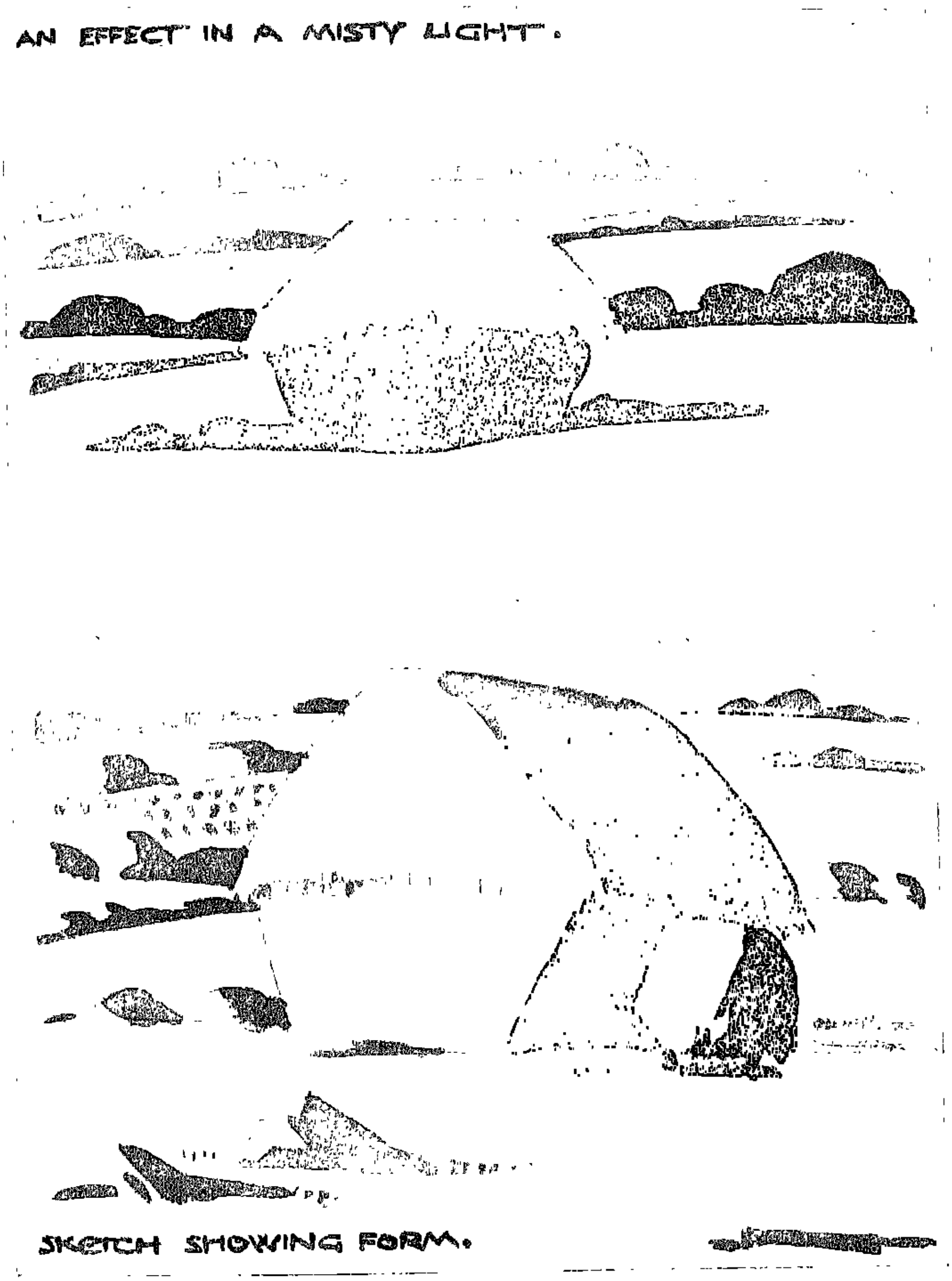

AN EFFECT IN A MISTY LIGHT.
P. B.
SKETCH SHOWING FORM.

PLATE IV

LIGHT AND SHADE

These two sketches are of the same view, but one was drawn in a strong light and the other in a dim light. They illustrate how essential it is that the principle of shading should be thoroughly understood to produce significant sketches.

PLATE V. HOW TO MIX WATER COLOUR

A child should not need to be taught to draw, because drawing is a natural activity. He can, however, be helped to think intelligently about all that he sees and to express himself intelligently, and he needs a variety of materials and to be shown how to use them.

Materials and tools determine the character of work almost as much as the person who is doing it. Water colour is a medium which gives a great deal of pleasure; it is so sensitive that it arouses the colour sense until colour becomes something to think about, and it is most delightful for simple direct sketching.

Charts of students' colours, samples of papers and other materials can be had from the recognised artist's colourman. Crimson, vermilion, Ostwald orange, gamboge, yellow ochre, viridien, ultramarine, Ostwald purple, burnt sienna, make a good student's palette. These few colours are sufficient. Their full intensity is seen on a white rough-surfaced paper. A large brush encourages more generous work. Dirty pigments, dirty palettes, grey water, cannot give clear vital colour. Two jars of water are used, one for washing the brush and one containing clean water for mixing.

Use each pigment in turn. Mix a puddle of colour and find by experiment how to get the full colour from each one. Before painting, tilt the board. Begin at the top with a full brush and run the colour on horizontally and down. Keep the board sloping until the colour is quite dry. Do not go over the surface a second time. A pigment cannot give more than a certain intensity of colour; if, after mixing a certain amount of colour more colour is added, the patch will be dark and look dull when it is dry. Look at the colour of each pigment at its full intensity: crimson is a rich purple red, vermilion is an orange red, yellow ochre is a brown yellow, gamboge is a cool yellow. Each colour at its full intensity has a particular tone; yellow is lighter than orange, orange is lighter than blue.

It is good practice to do some drawing directly in brush and also with strong pencil line and wash with these few colours, without mixing. By working constantly with a few full rich colours, each colour in itself and its effect on other colours is realised.

Experiments will show what can be done by mixing. Gamboge and a touch of viridien give green-yellow. Orange and burnt sienna give brown-orange. Viridien and gamboge give yellow-green. Purple and crimson give crimson-purple. Burnt sienna and ultramarine give grey-brown, brown-grey and grey. A colour is not made darker by adding more and more pigment, but by the addition of a certain colour or certain other colours. Crimson, a touch of ultramarine and burnt sienna give dark crimson. Viridien, ultramarine and burnt sienna give dark green. Ultramarine and burnt sienna will give dark blue. Purple and burnt sienna will give dark purple. Burnt sienna, crimson and ultramarine will give dark brown.

Learning to see colour, to mix pigments, and to get clean vibrating patches of colour is a matter for sketch after sketch. Museums and schools have created an idea that nothing but carefully "finished" work is of any merit. Rapid fresh sketches showing the lights and darks of clean coloured objects, sketches from life with suggestions of flat colour run on and untouched are far more sincere than a good deal of "finished" work.

It is useful to make clear notes of the colours which have been used on all experimental sketches.

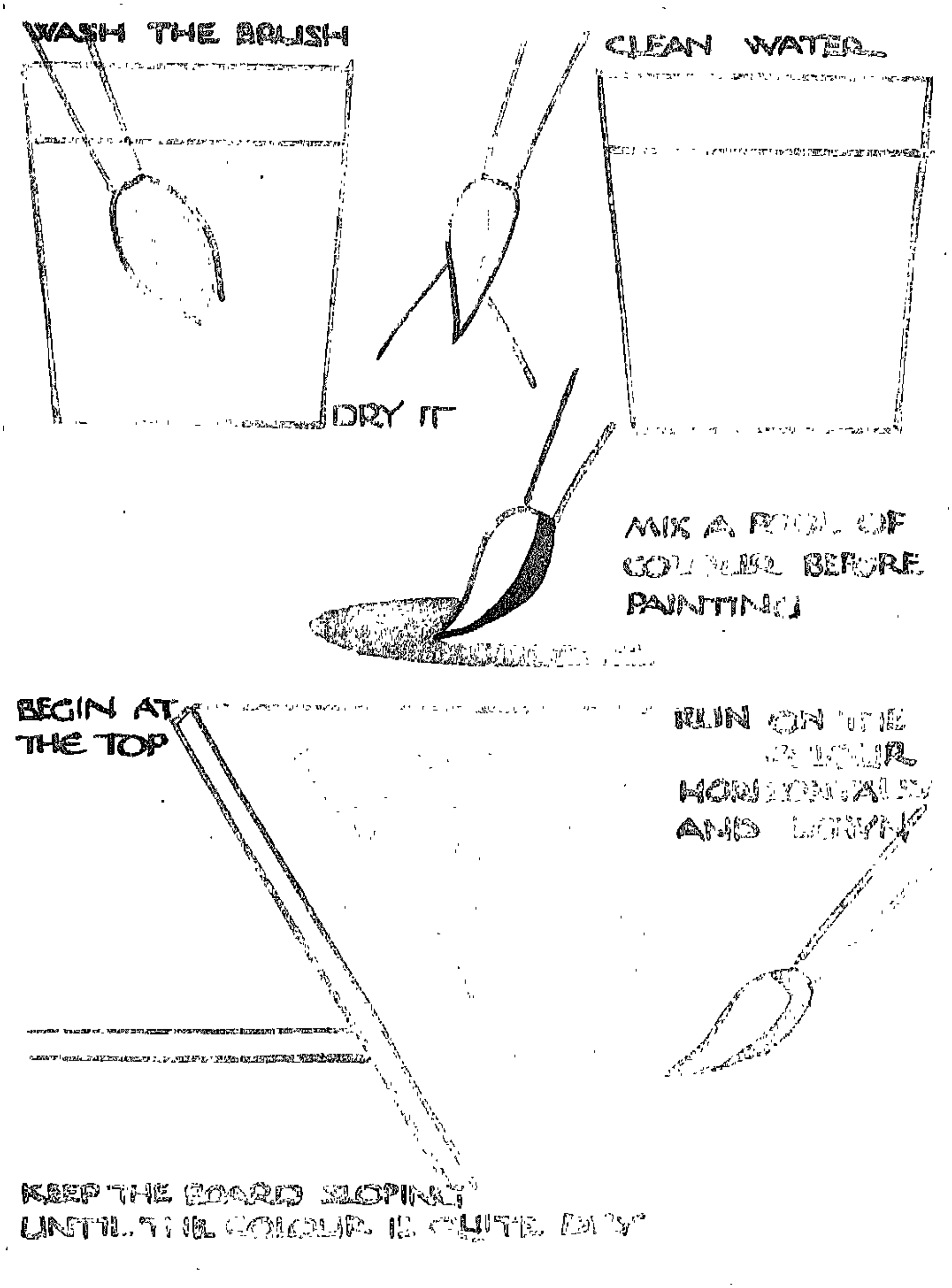

WASH THE BRUSH
CLEAN WATER
DRY IT
MIX A POOL OF COLOUR BEFORE PAINTING
BEGIN AT THE TOP
RUN ON THE COLOUR HORIZONTALLY AND DOWN
KEEP THE BOARD SLOPING UNTIL THE COLOUR IS QUITE DRY

PLATE V

MIXING AND RUNNING ON WATER COLOUR

Learning to mix water colours is the first and most important part of water colour sketching. It is impossible to make fresh, vital sketches unless the fundamental technicalities of the craft are understood.

PLATE VI. THE WATER COLOUR BRUSH

Large brushes cover the ground quickly and thus give a sense of power. Small ones prevent freedom and produce small work, for which alone they should be used. Brushes have to be carefully chosen because they must come to a perfect point. Red sables are the best but squirrel hair is less expensive and a No. 10 is a useful size. They must be kept clean and not crushed out of shape. Never stand brushes on their tips or they will be ruined. Licking a brush spoils the point, which can be made by drawing it down a piece of blotting paper, or dipping it in water and shaking it. The point of a brush is more sensitive than that of any other medium. It encourages a flow of line and colour which makes it most pleasant to use.

Rapid line sketches drawn freely over the whole of a large piece of paper help to produce facility. The lines cannot be rubbed out. They must be direct, which is a very useful training. If a mistake is made it has to be accepted. Drawings should be sincere, but "perfect" work is far from being always the most attractive or interesting. Sometimes the charm of old work is to see those inaccuracies, or straightforward corrections, which make them simple human documents.

Flowing line work can give rhythm and vitality. Before drawing the fins of the fish and the spine of the hedgehog in Plate VI, the directions of the strokes were realised and decided; then the lines were drawn evenly and rapidly without a break.

A subject for silhouette should explain itself clearly by its shape; also, it should be attractive in shape. To get a good surface, all shapes, large and small, are run on with a wet brush. The drawing board should be tilted and the painting begun from the top. The shape is formed quickly and decidedly as the colour is run on. It is always best to work as horizontally as possible, otherwise, going back to the top of the surface may mean running wet colour into colour which is already drying, and the surface will be spoiled at once. In silhouette drawing, one has to work as one can—horizontally, vertically or slanting—therefore it has to be rapid to prevent uneven drying.

The hedgehog is in flat wash and line. The flat wash for the nose and face were run on first. Then the brush was regulated and radiated to give the rhythm of the spines. The head was dry by then so the dark shapes of the nostril, the ear, and the still darker shape of the eye were drawn in.

Drawings which are neither line nor silhouette are a combination of carefully drawn shapes and lines. Whether the colour area is flat or graded, it has to have meaning, so that it is as well to be able to control the brush easily.

Line work is refined. Silhouette is powerful and convincing. Direct brush drawing has a peculiar charm. The slight changes of tone in line and wash give it its peculiar quality.

Curled autumn leaves, trees in winter, swimming fish, running zebras—such subjects give opportunity for drawing in rapid rhythmic lines. Naturally, children like movement and humour; brush drawing gives a good opportunity of exercising both simply and easily. Effects of contrast in the size of the subjects, or in the tone or the colour, add considerably to the interest.

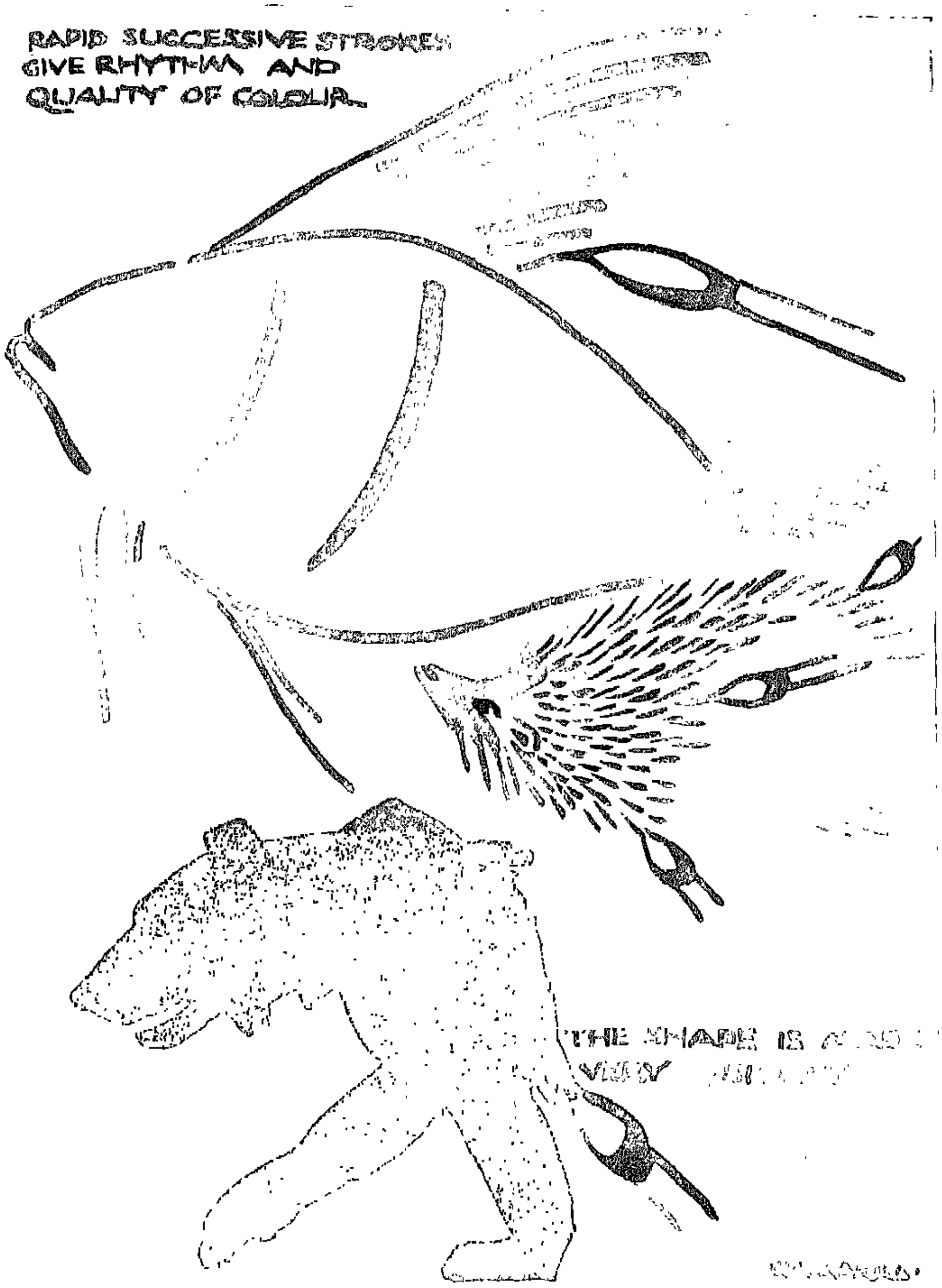


PLATE VI

SKETCHES WITH THE WATER COLOUR BRUSH

This Plate illustrates a variety of effects possible with the water colour brush. In every case, the desired effect was decided upon before the sketch was begun, thus ensuring vivid, firm work.

PLATE VII. HOW TO RUN ON WATER COLOUR

Mental laziness on the part of the pupils is a difficulty which all teachers will have to face. There is the temptation to use the wrong materials, to work untidily and with dirty water and palettes, and to go over the drawing again and again, trying to think it is getting better. It is far easier to begin and go on in a way which will give clean vital colour.

Colours in nature blend one into another and grade from dark to light and from light to dark with no perceptible change. Autumn leaves are rich examples of blended and graded colours. To blend the colours in a leaf first mix each colour that is seen, separately. Slope the board and hold it steadily. Begin at the top of the surface and, working horizontally down, run on each colour as it comes. The running down has to be allowed for but it is easy to discover when to change from one colour to another. The second leaf on the beech spray in Plate VII grades from dark to light, but it is in a difficult position. The dark was begun at the top and run horizontally down, then a brush of water was swept down the right side.

The dark of the chestnut fruit was run down very quickly, and the light swept down on either side of the dark. The colours were thus made to blend and grade without a hard edge.

The third leaf on the beech spray had, at the top, two dark patches with hard edges. They were run on first with a wet brush. When they were dry the light colour of the rest of the leaf was run down to the dark at the bottom of the leaf. When this was dry the lowest dark patch was put on.

The first beech leaf was rich dark brown in colour and the bud stood out light against it; therefore, whichever was painted first had to dry before the other was put in. Again, the dark of the chestnut leaf was left to dry before the light colour of the curled end was run on.

Experiment soon shows how to guide and *control the colour. It does not matter if* the patches and changes do not come exactly in the same places as they do on the leaf. It is far better to get the vitality of the colour, which gives the spirit of the leaf.

Going over a colour again rubs and chokes the surface of the paper and the colour gradually appears more dark and dirty. Decide what to do and concentrate on that. If the result is unsatisfactory, make a fresh beginning.

The following suggestions may be helpful in introducing children to this section of the book. Use a large brush, show how to prepare the colours for a leaf and how to blend them one into another without a hard line. Show how to grade a colour from dark to light and from light to dark. Explain that it is very often necessary to let a colour dry before putting on the one next to it. Help the children to understand that if they really want to know how to use colour they must make experiments and discover for themselves; it is thrilling to be able to get beautiful colour.

Leaves of all kinds are useful for experiments. In autumn, beech, chestnut, and oak have rich colours. Cabbage leaves are usually most attractive in colour. An orange, a green apple, a lemon, a radish, pieces of red, orange, yellow, green, blue and violet paper folded and placed like the book in Plate I make good models. These are not useless exercises, they develop the sense of colour. Artists are not the only people who want to know what colour has to teach them. Everyone has to choose clothes and furnish houses and do numerous things which it is impossible to do really well without knowing something about colour; also, we learn by doing.

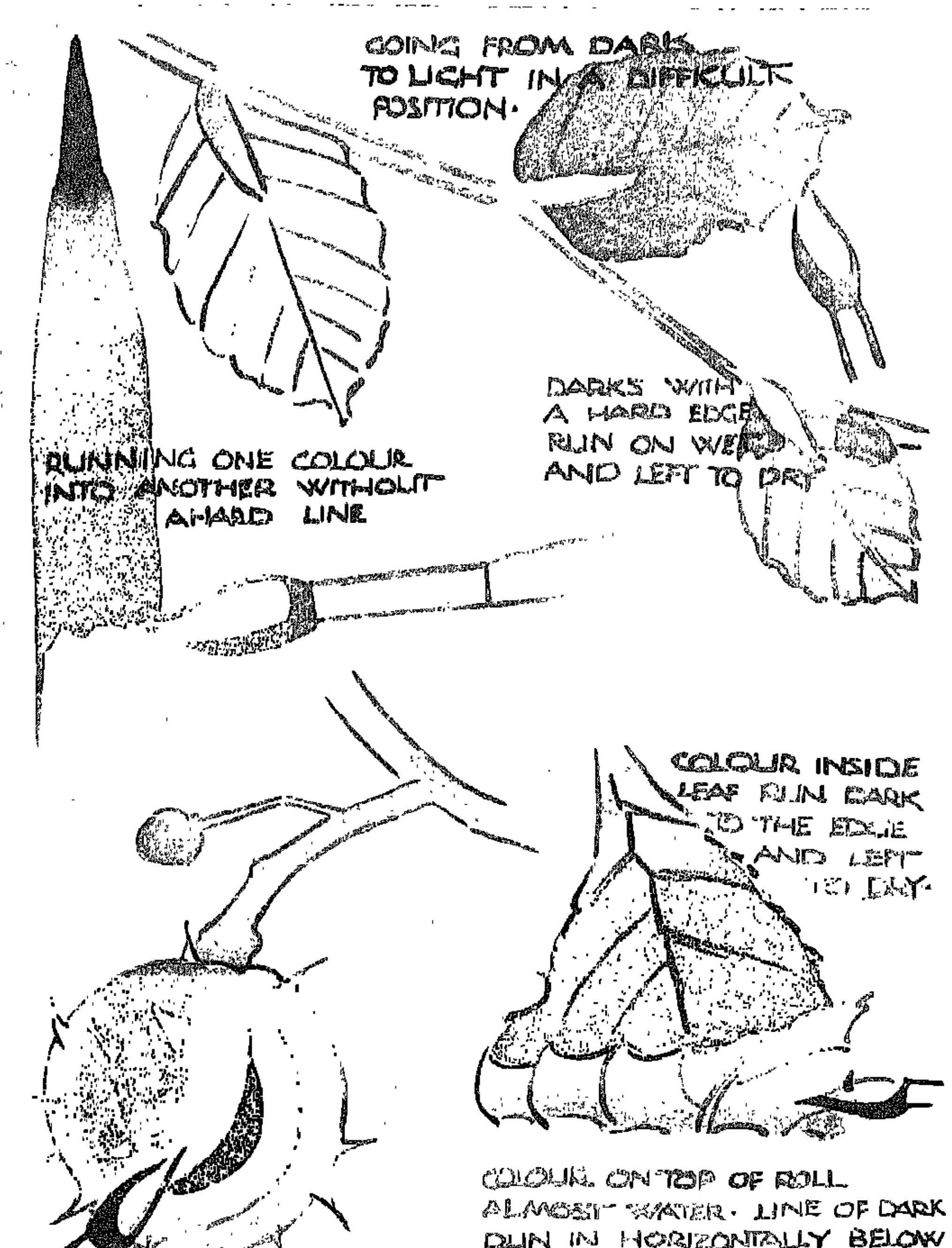

GOING FROM DARK TO LIGHT IN A DIFFICULT POSITION·
RUNNING ONE COLOUR INTO ANOTHER WITHOUT A HARD LINE
DARKS WITH A HARD EDGE RUN ON WET AND LEFT TO DRY
COLOUR INSIDE LEAF RUN DARK TO THE EDGE AND LEFT TO DRY·
COLOUR ON TOP OF ROLL ALMOST WATER · LINE OF DARK RUN IN HORIZONTALLY BELOW

PLATE VII

RUNNING ON WATER COLOUR

It is essential to learn to blend water colours softly. Leaves afford excellent examples for experiments, for it is only by constant trials that finally the right use of colour will be discovered.

PLATE VIII. POWDER COLOURS

The substance of powder colours makes them suitable for work on a large scale. They have not the same sensitive quality of ordinary water colour which is so valuable in the development of the colour sense, but because they get over large areas easily they give confidence with which to tackle bigger work.

Too much small work gives a cramped outlook, and it does not give the joy and freedom which should be qualities of developing expression. Those who do not want to do large drawings may like to do larger pieces of craft work. The value of working in generous proportions is great.

Everyone need not do large work at the same time. It is best to encourage children to plan and work out their own varied ideas in the ways which are most suitable for their purpose.

One of the great advantages of large drawings is that they have to be seen from a distance. It is necessary to stand to work at them and move away to look at them. Sitting for a long time at a piece of work which may be going too slowly sometimes results in a sleepy, inactive mind.

If it is not possible to have an easel, the drawing can be put on the seat of a chair, leaning against the back.

A rough-surfaced paper is required for colour work. Beaver board is useful for particular pieces of work. A hog hair brush is used for large surfaces, and a large water colour brush for smaller ones. Two jars of water are required. The colour is taken and mixed with a small palette knife, which is always cleaned after use. Nests of saucers which fit together are most satisfactory because colour will keep moist in them for some time.

The colour can be used either thick or thin but in order to obtain a good surface, it should not be too thick. The mixture should be smooth and sufficient colour for the purpose should be mixed at the beginning. The colour cannot be judged until it is dry, and if enough is not mixed, it takes a long time to match it.

Whether it is used thick or thin, it should be run on evenly, to dry flat.

It is best to decide what to do and to work directly, accepting mistakes instead of going over the surfaces a second time. Direct work always has a far better quality and is usually a more intelligent way of working. Indecision in drawing is not helpful.

The brush should be quite clean before taking and laying on a new colour.

If colour that is left over is well moistened it can be used again after the superfluous water has been run off. It is not advisable to use colour which has gone quite dry.

Meanness in saving colours of any kind is not really wise. With these colours, it is better to consider what will be wanted, and then to clean the palettes after use. It is far more pleasant and encouraging to begin work with clean palettes and fresh colour.

These large areas of colour not only give great opportunities for vigorous work but also they give rise to a sense of ability, at the same time suggesting possibilities for many kinds of original sketches. The effect of colours on each other can also be seen clearly, thus arousing a desire to choose them carefully and arrange them to their greatest advantage.

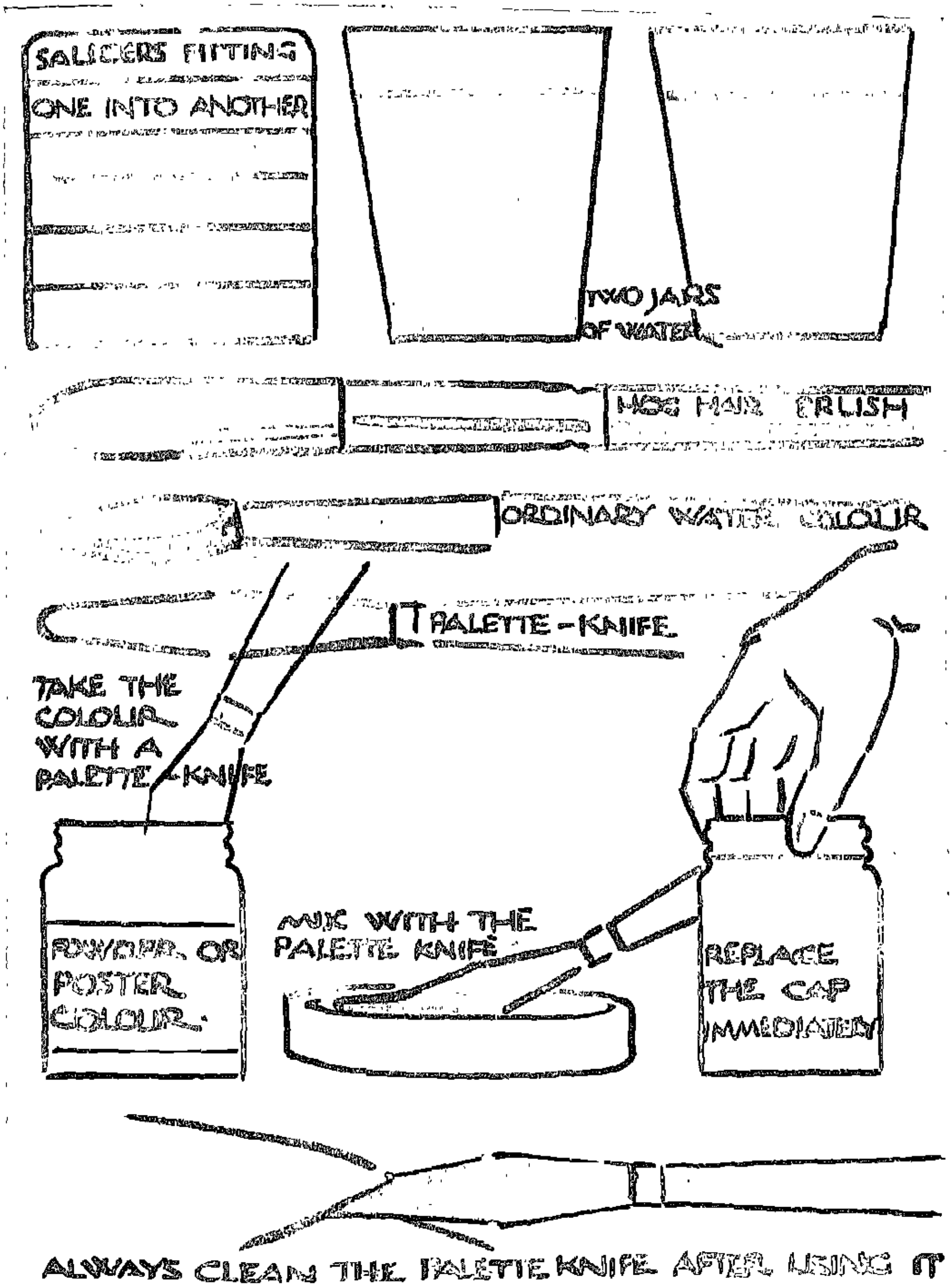

SAUCERS FITTING ONE INTO ANOTHER
TWO JARS OF WATER
HOG HAIR BRUSH
ORDINARY WATER COLOUR
PALETTE-KNIFE
TAKE THE COLOUR WITH A PALETTE-KNIFE
POWDER OR POSTER COLOUR
MIX WITH THE PALETTE KNIFE
REPLACE THE CAP IMMEDIATELY
ALWAYS CLEAN THE PALETTE KNIFE AFTER USING IT

PLATE VIII

USING POWDER COLOUR

Powder colour is useful for covering a large area of space, thus giving scope for great freedom. It also encourages the desire to produce vital forceful drawings, and on account of the boldness of treatment necessary, gives confidence to the timid pupil.

PLATE IX. THE PRACTICAL VALUE OF DRAWING

As children get older they often lose interest in drawing. Two of the reasons may be that they do not realise that it is a wonderful means of expression and that it makes us think about what we see. It has always been a means of expression, and the carvings, paintings and drawings of the various races, nations and schools give a great deal of information about the people who made them and the times in which they lived. Children's drawings are also records which show their interests and imaginations, their observation of people, of nature, in science and in other things. By practising drawing, we come to see the colour and proportion of whatever is before us in a different way: to think over what we see and understand what it means. We become more sensitive and recognise people and animals of good appearance, houses and furniture which are good in proportion and pleasant in colour; we come to prefer the best, realising these are signs of essentials and that they are important.

We begin to want good colour and proportion in our surroundings as the Greeks wanted fine well-proportioned people as well as graceful statues.

Colour is so attractive and so vital that once its effect and value are realised, it becomes a matter of absorbing interest.

One beautiful effect of colour was obtained in the living-room of a farmhouse in Cornwall during the winter. The walls were plain and light, the windows low with a broad seat. The furniture was thin, dark oak. Here and there were pieces of coloured china and pewter or a great flat dish of oranges. The fireplace was red brick, with logs always burning. At tea-time, the table was lit with a large lamp and its shade sent a warm rosy glow over the whole comfortable room. The impression was one of colourful vitality.

Lately, I have watched another house change its tenants. The old atmosphere of colour and flowers and life is gone. The windows are generally shut and blocked with old dark furniture and dull curtains. At night, the lights are dull and the curtains are gloomy. There is no vitality. It is obvious that light and colour are not precious to the new tenants—no one thinks about them.

A collection of postcards and small reproductions of drawings, paintings and carvings of subjects within children's interests (beginning with the prehistoric animal carvings) is useful. If a boy has his one interesting picture he can write what he discovers from it; he can read another boy's drawing also, and realise that they are all records from which much can be learned.

Children can demonstrate for themselves what is shown in Plate IX—that making a picture, choosing and arranging flowers, staging a play, choosing and arranging furniture, all mean choosing and arranging colours, shapes and lines. If the shapes and colours in each case are as simple and large as possible, the idea is clear.

If the scene for the play were staged first in dull uninteresting colours and then in clean, clear ones it would demonstrate the vitalising effect of colour.

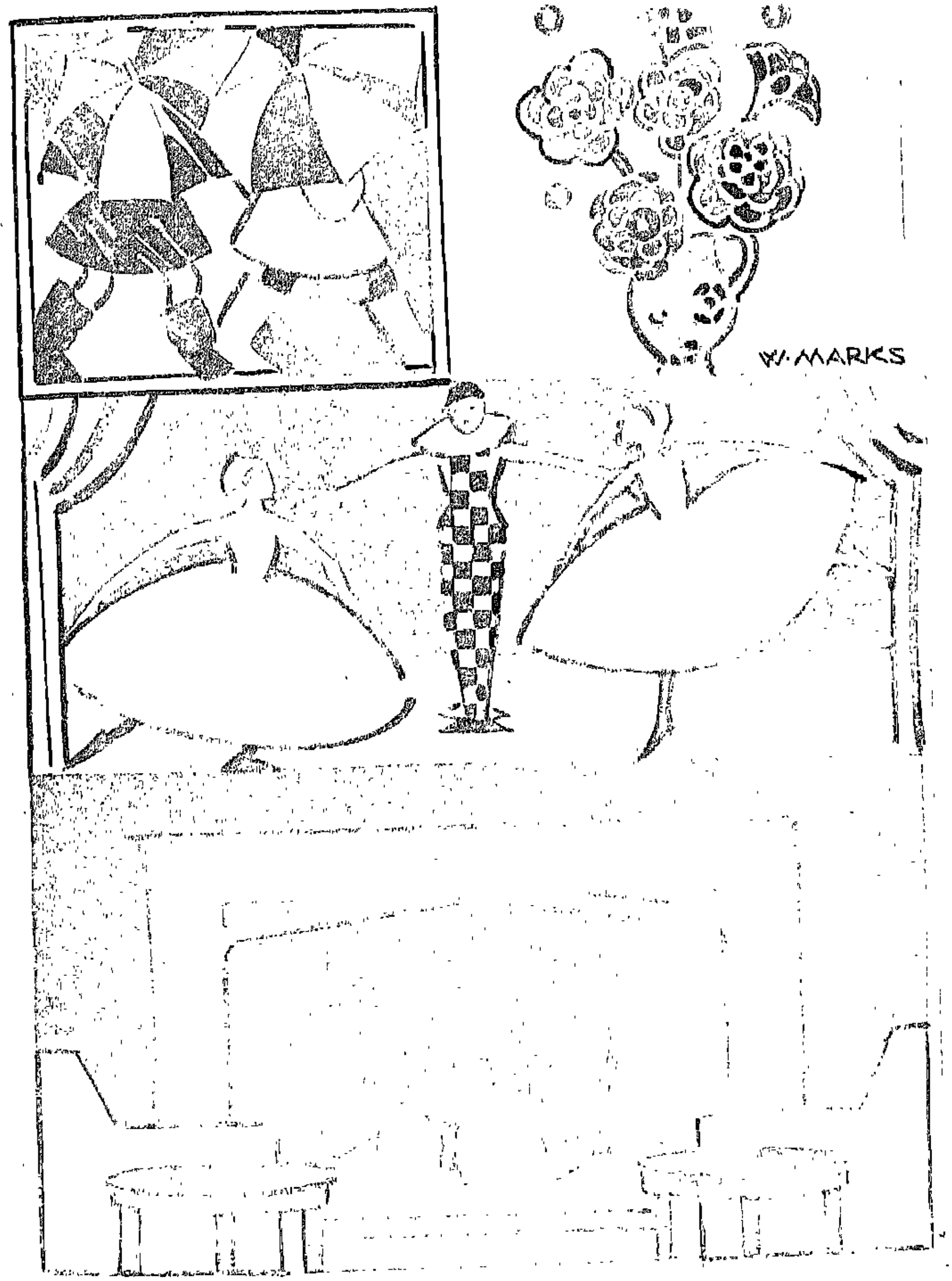


PLATE IX

THE PRACTICAL VALUE OF DRAWING

Drawing develops the desire to create useful and beautiful things in everyday life. This Plate shows how this desire can be gratified. A training in drawing makes it possible to arrange flowers, stage a play or arrange furniture artistically and well.

PLATE X. PROPORTION AND STRUCTURE

Line or proportion is an outcome of structure, and in nature and in simple straightforward craft work, the structure results from necessity.

A bird is an example of nature providing for circumstance. The body has to be compact and light, therefore the bones are hollow and the heavy parts are near the *centre of gravity*. The head, wings, tail and legs are light; the heavy muscles to work them are close to the body. The light tendons go to the outer parts. The eyes adjust to distance and moving objects with the utmost rapidity.

It would be very good if every part of the things which we make were necessary and able to do their work perfectly. Most simple things are like that.

A circular bowl for food or drink is a perfectly balanced form: sometimes it has a small base which makes it more convenient to hold; it is neither too shallow nor too deep for convenience; for cleanliness it is smooth inside and out. A spoon has a bowl for food or drink, a slender stem with which to hold it, a more weighty end for balance and finish. A pail is made in a size to take as much water as it is convenient to carry; the handle holds it loosely so that it can sway without spilling; it is raised with a rim about 2 in. from the ground, so that the bottom will not wear away so readily.

When people had to make the things which were needed for everyday use before machines took the place of hands, they were interested in finding the materials which were best suited to their purpose, and in fashioning the materials to make the most serviceable tools. It was that keen sincere desire to produce the best which has given the colour, proportion and charm of the past.

The really good thing fulfils its purpose as well as possible—an animal, a plant, a play, a chair, a picture—the parts of each and their arrangement are necessary for the fulfilment of its purpose.

Suitable structure is not mean. Poor proportions will ruin anything. Narrow doors and fireplaces can spoil a well-proportioned room. A narrow path in a small garden is less useful than a wide one, and in addition it makes the garden look still smaller. A small room is better with one or two large comfortable chairs than several small uncomfortable ones.

It will interest children to talk over and think about the structure of familiar animals and plants, to discover the necessity for and the perfection of their forms. It is illuminating to look at some of the things which are in daily use. Cups, teapots, jugs and various other things of a similar nature (which should be as simple as possible) are made frequently with useless forms and ridges which make it impossible for them to be kept really clean. Houses are still full of ledges and ridges which are only dust traps.

A straightforward understanding outlook concentrating on essentials, avoids these unnecessary additions as superfluous.

Well-chosen, fairly large photographs of a well-bred horse or dog taken from the side, of the Roman letters from Trajan's column, of simply furnished rooms, of well-proportioned furniture, would emphasise the pleasant effect of simple structure and good proportion.

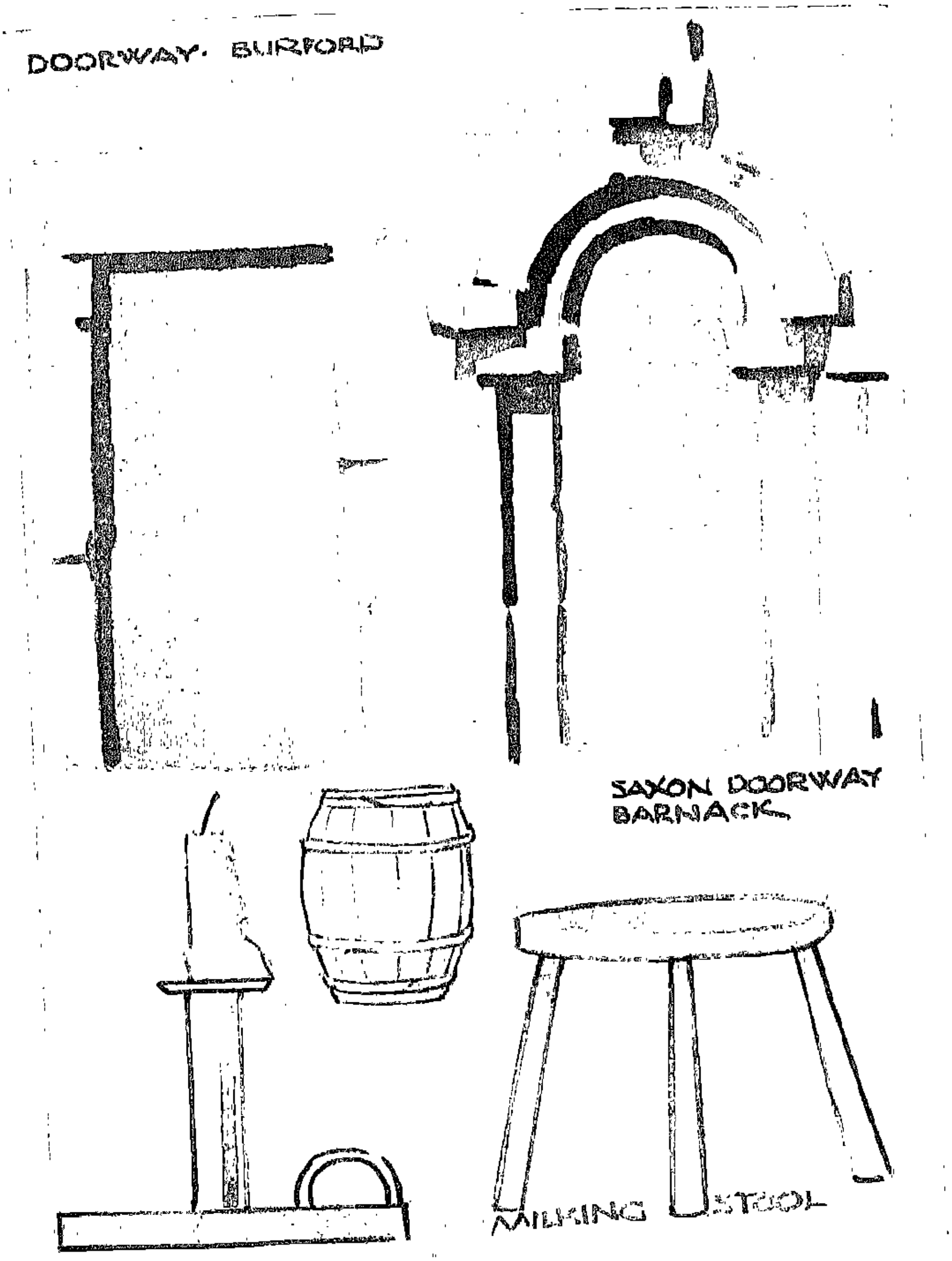


PLATE X

SIMPLE NECESSARY STRUCTURE

This Plate illustrates the necessity of structure, even in the most simple objects. In all forms of simple craft work, structure is the outcome of necessity; and from structure is developed the desirability for artistic line and good proportion.

PLATE XI. PATTERN WHICH IS AN OUTCOME OF STRUCTURE AND ADDED DECORATION

The structure of many things necessitates an even repetition of similar parts which give a pattern in the making. The structure of the honeycomb, the repetition of the scales of fish give beautiful patterns. Weaving, building with brick, rope making has similar results. But from the earliest times there have been people who, simply for pleasure, like to add decorations to their work.

Among the earliest added decorations were those made by the prehistoric potter. The simple crude markings on some of the unevenly shaped pots seem to have been done in an idle absent-minded way, as one sometimes makes a pattern with lines or dots on the blotting paper. Others show some beautiful results requiring far more concentrated effort.

The Normans must have been attracted by the idea of the rope and the rhythmic flow of its strands. The cable moulding is an effective addition to their solid structure. The fish-scale pattern was equally pleasing to them for there are numerous examples of it in their work.

Added decoration is a matter for individual choice, but unfortunately the practice of making patterns and decorations for no *purpose* has somewhat robbed the word design of its true meaning.

In designing, planning, arranging anything, the first thing to think about and then to remember all the time the work is being done is *its purpose*. What are the essentials? Are they here? Are all these parts really necessary? In time, the artist having this point of view discovers the right materials for requisite parts, and the best arrangement for the purpose. There may be a pattern in the making. If there are added decorations they should be planned from the first.

Perhaps it is a little false to begin with the intention of making a good design, of getting repetition and good balance for, by concentrating on the essentials, the design should work itself out.

Balance is necessary. Nature is balanced. The desire to make things balanced is natural to most of us, and on the whole we find it satisfying. The arrangement of the ornaments on the mantelpiece is one of the most common results of our passionate desire for balance; the careful arrangement of a plant between evenly draped curtains is perhaps the most amusing one.

With the children it is advisable to discuss pattern which occurs in the making, and in added decoration, explaining that such decorating is a secondary consideration. We begin work by thinking over its purpose and keeping that in mind the whole time, whether or no we add decorations.

Making useless things destroys interest, encourages poor results and creates a wrong outlook. If a boy can make a toy, or a chair, or a bookshelf for his home; if a girl is making clothes for herself or her sister, the work is a matter of keen interest and the adjusting of part to part and colour to colour is a pleasure, and the innate spirit of craftsmanship is satisfied. Discussion can discover where proportion has been mean, what parts could have been done without, what proportion seems right, and in what other ways the work could have been satisfactorily done.

Good taste is personal; but by creating a keen desire to see how simply a thing can be done its development is greatly encouraged.

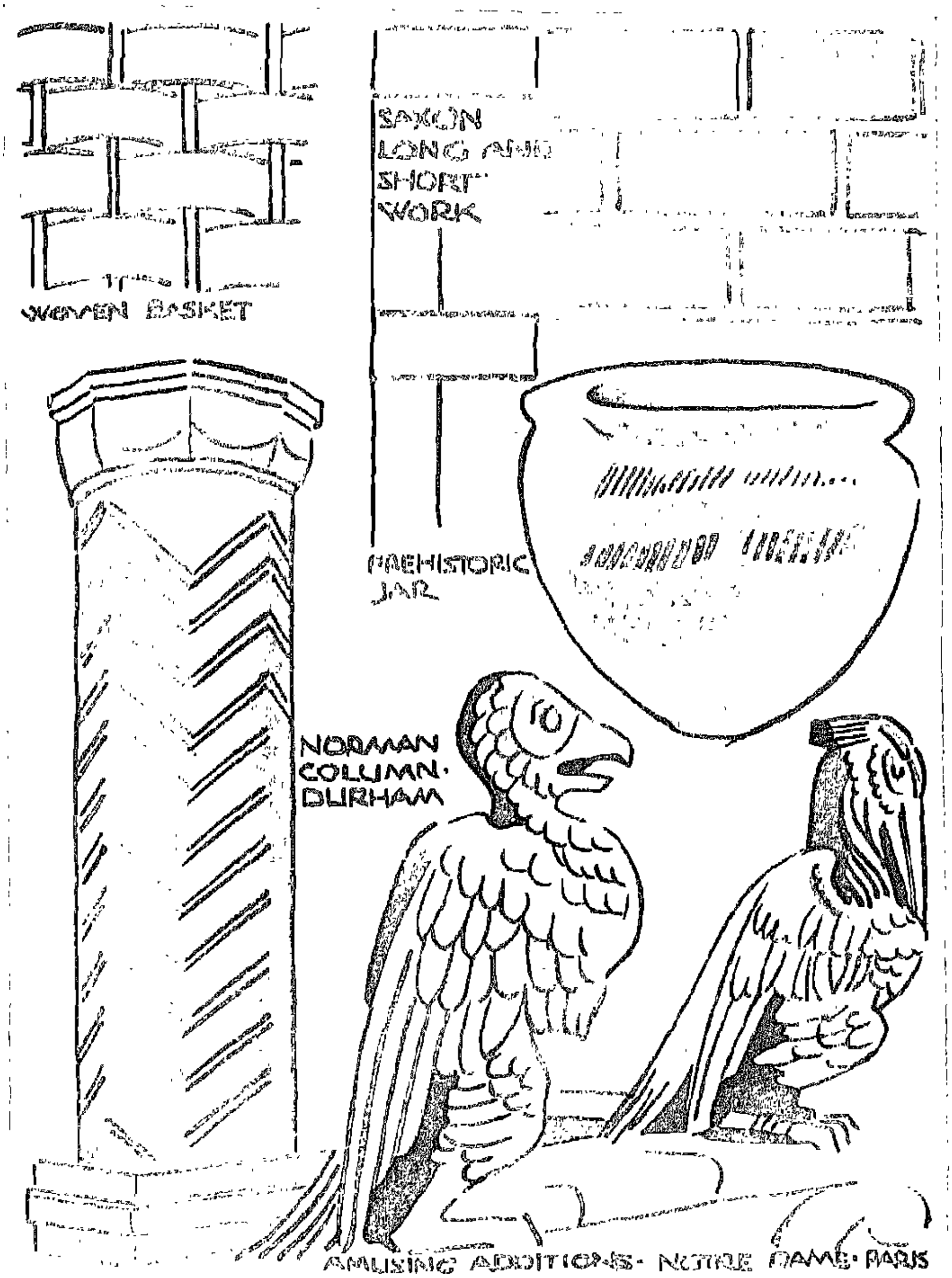

WOVEN BASKET
SAXON LONG AND SHORT WORK
PREHISTORIC JAR
NORMAN COLUMN. DURHAM
AMUSING ADDITIONS · NOTRE DAME · PARIS

PLATE XI

PATTERN WHICH IS AN OUTCOME OF STRUCTURE AND ADDED DECORATION

The woven basket, the Saxon work and the brick work are examples of pattern which is an outcome of structure. The prehistoric jar, and the Norman column have added decorations. The carvings from Notre Dame are added decorations of a different kind.

PLATE XII. MATERIALS

No one can be really successful if he works with materials which are unsuitable for his purpose. A good craftsman tries different tools and different mediums in order that he may make a right choice. Some people do not study materials or trouble to find the best for their purpose; through ignorance or carelessness they choose unwisely and the work is unsatisfactory because it cannot fulfil its purpose. Learning about materials means a good deal of searching out and a great many trials, but it saves time in the end and gives confidence for work.

The purpose of any work has to be carefully thought over before the materials for it can be chosen. The binding for a book has to be suitable for the person who is going to use it and for the book itself. A dress has to be suitable in texture for the wearer and for the time and place when it will be worn; the colour has to be right for the colouring of the wearer.

The frame of a picture has to help the picture and take its part on the wall where it will hang. Large white mounts and small black frames may be neat, but they are so dazzling that the eye cannot concentrate on the picture. They attract the eye in the most unpleasant way and so destroy the harmony of the wall.

Curtains should not annoy the eye from the outside (if they are seen) or from the inside either by their texture, or by their colour. Both the colour and texture should be *right for the room and the time of year.* Some really attractive curtains were in a room where sheep used to wander past the window. They were green with pictures of sheep all over them. The walls were white and caught the sun, and the room was simple, so that the pattern was not overpowering but attractive.

Another room had for winter use blood-red velvet curtains of a beautiful texture; another pleasant patch of colour was made by a vermilion twill curtain which caught the sun on its folds in a most cheerful way in the morning.

It is a help to have a choice of material in any craft and to make small trials in different ones to learn their nature and how to use them. This introduces a subject of *vast importance; it exercises the imagination* and develops an intelligent creative outlook.

Similar things could be worked out in different materials—baskets in rush and cane; bags in woven stuff and canvas, the materials being adjusted in each case to size, shape and particular purpose.

Naturally, children should learn to do what they can with what they have. It is fun; it is a marvellous exercise of intelligence and a fine thing to have to do. Children should learn to use inexpensive materials first. Prehistoric people had such a great desire to draw that their interest made them find adequate materials. They had sufficient interest in colour to discover red and yellow ochre and a black for painting. A time comes, however, when good materials have to be chosen and used. Samples and pictures of good materials in use for clothes, furniture, household and other purposes would train the children to make a useful and suitable choice *when opportunity occurs.*

Money is wasted so often and the appearance of homes frequently spoilt, because people have not learned to think about these things.

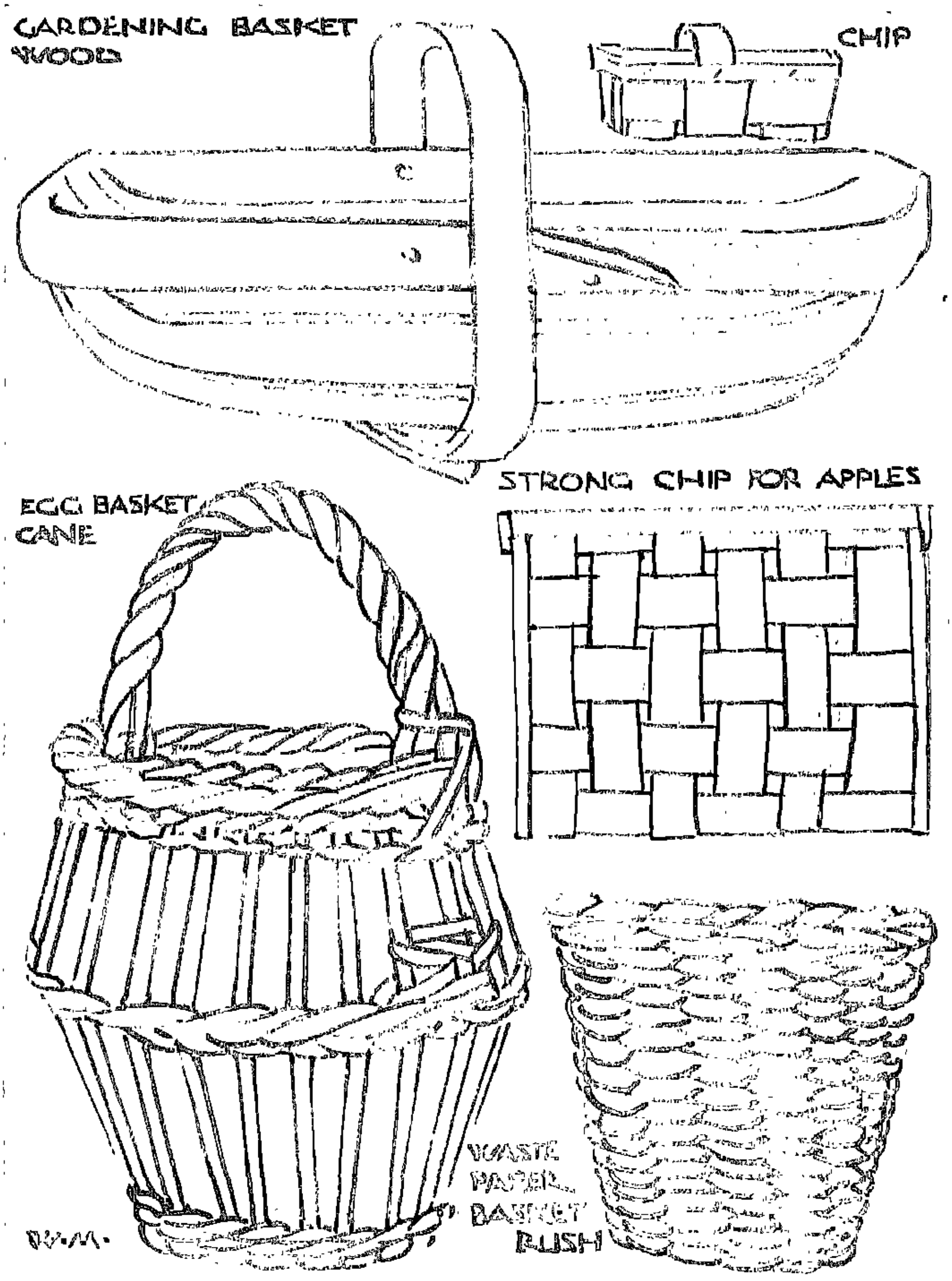


PLATE XII

Baskets worked in Different Materials

The choice of the right material with which to carry out any work is of the utmost importance. Learning about materials, their uses and their suitability to the work in hand is a matter for constant experiment, observation and thought.

PLATE XIII. COLOUR AND PROPORTION IN EVERYDAY LIFE

The desire to know about colour and proportion and materials is not the beginning and not the end. Certain things are here already and the new things have to be considered also.

How is good colour and proportion to come out of bad, and how are new things to be kept in order? The old things have to be made clean and the new things have to be kept clean. Any surface which is dirty cannot look its best. Walls or floors or windows or clothes—nothing can look clean unless it is clean, and kept clean regularly. People sometimes wear dark clothes and use a dark paint because they think they will not show the dirt; but dark colours absorb most of the light which falls on them and when they are dirty they reflect spots of drab grey light and have a most depressing effect. Dark surfaces have to be just as clean as light ones to be in order.

Space is also necessary. How many houses and rooms and cupboards and gardens are stored with rubbish which "may be useful sometime?" How many walls still are hung with useless ugly pictures in dingy frames? How many dreadfully shaped ornaments and jam jars still ruin the flowers that are crammed into them? A little more waste would be preferable for space is more pleasant than any of these things.

The study of appearances, how to get them and how to keep them, is not useless or superficial—rather, it gives direct contact with realities.

The appearance of drab colours is depressing—it means that there is lack of vitality behind. The appearance of sordid things is unpleasant—it means an absence of things that matter. Right training leads us to be sensitive and shudder at these things—then there is hope of change.

Unfortunately, it is usual to be attached to the familiar, simply because it is familiar, without realising its effect. It is possible to have beautiful things or ugly things always before one without being conscious of them. The schoolroom should be as bright and artistic as it is possible to make it. One or two good pictures, a few flowers in season, spotless cleanliness, a new dress, a smart hat—all these things, individually insignificant, can collectively have a marvellous *effect on a child's temperament.*

It is easy to draw a child's attention to colour in the country. There are buttercup fields, orchards of apple blossom; sunny spring mornings, sunny frosty mornings, feasts of colour everywhere. They can be the means for arousing a real desire for clean clear colour in everyday life. In town, drab colours are all too familiar and the teacher has to depend much more on herself to arouse a desire for clean clear colour.

To work with clear colours in craft work, to learn to be clean and bright in appearance and to take care of one's possessions and use them in the right way, makes the subject eminently practical. Because it is possible to have things before one without knowing it, slow minds want practical ways of arousing their attention—to make an untidy cupboard clean and tidy, to keep it tidy, to do a large piece of work in beautiful colours—such things are stimulating.

Different mentalities are stirred in different ways to think about what they see, and are only gradually encouraged to make practical use of their observation in everyday life.

Order, in its highest sense, is closely akin to beauty.

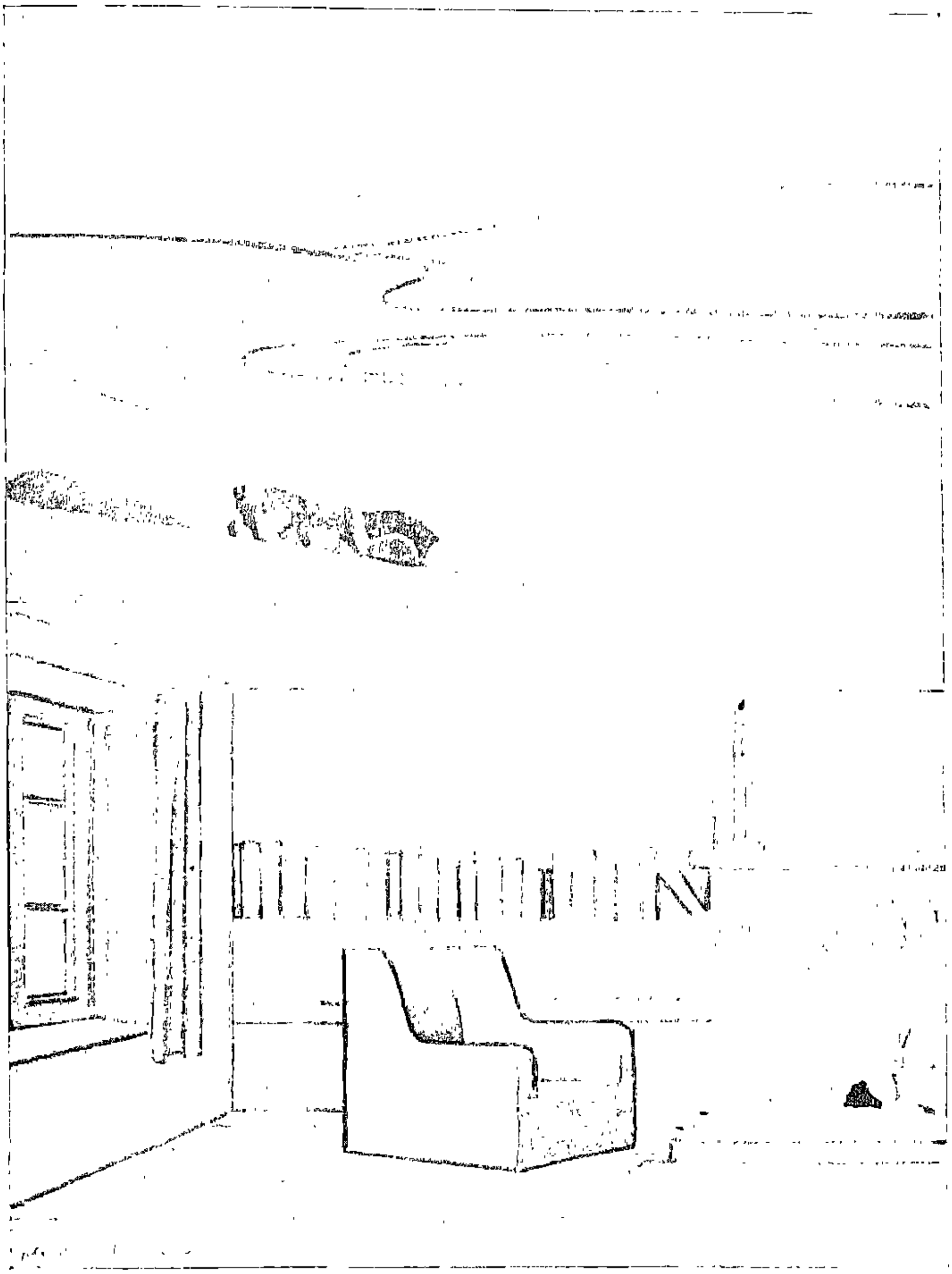


PLATE XIII

SPACE

The artistic quality of space is often forgotten. Order and beauty are closely allied as can be seen from the examples in the above Plate, where the wide sweep of the hills and the uncrowded room are far more beautiful than would be an overcrowded scene or a room full of useless ornaments.

PLATE XIV. MEMORY DRAWING—I

The boy reading in Plate XIV is a character sketch from memory. As I drew, I thought intently about his personality. I remembered his thoughtful manner, and characteristic movements; how carefully he would hold the book and think over all that he was looking at. The sketch is not freely drawn because I did not think about his personality only—I thought about anatomy and perspective also. I remembered that I should see on top of the head, the face would be shortened, and I should not see the neck; the shoulders would be forward and the back comfortably rounded. I recalled the slope of the shoulders, their breadth, the position of the armpits, the foreshortening of the forearm, the slenderness of the wrists, and the cuffs going loosely round them. I remembered that in this position the hips would appear broader than the shoulders, and the upper part of the legs very foreshortened. I did not try to think out the actual tones which I might see with the light on the left of the figure, but made a simplified suggestion of the form.

In any kind of drawing, but especially in life work, the spirit of the thing is seized at once, or not at all. Having got it, it is better not to try to improve it, and whatever has to be added should be put in carefully.

Vital personality can hardly be got by rubbing out and retouching. For this reason a brush or a pen are both useful, because it is not practical to rub out either paint or ink.

Drawing indirectly means being undecided, a habit which can become very annoying and spoil a great many drawings. There is another point of view—a sincere piece of work may have many mistakes, but the sincerity of it gives it value and the mistakes make it a human document.

People viewed as subjects for the artist's pencil or brush quicken observation and stimulate expression more than any other subject. After concentrating on an interesting personality with the idea of sketching, I find it easy to make a drawing from memory; I think that after a little practice anyone who has a real desire to draw will find the same thing.

Character is shown in a person's whole figure—in his structure, pose and action—not only in his face. A back view may be as good a character sketch as a front view. Older children begin to notice and to think about the characters of people and some like doing character sketches. If they are encouraged to draw as they like—freely if they prefer it, or in perspective if they find that way best—this may be a direction in which mental development and expression can go forward together.

Whatever subjects are found interesting or in whatever way the drawing is done, a child should know what he is doing and work intelligently. When he is working from memory he should know it and realise that he is drawing by recalling past impressions. He should discover that it prepares him to see things, and makes him pay more attention to what he sees. He should know the use of memory in creative drawing, but realise that reproductive drawing either from the object or from memory is not a preparation for creative drawing only; the two go on together.

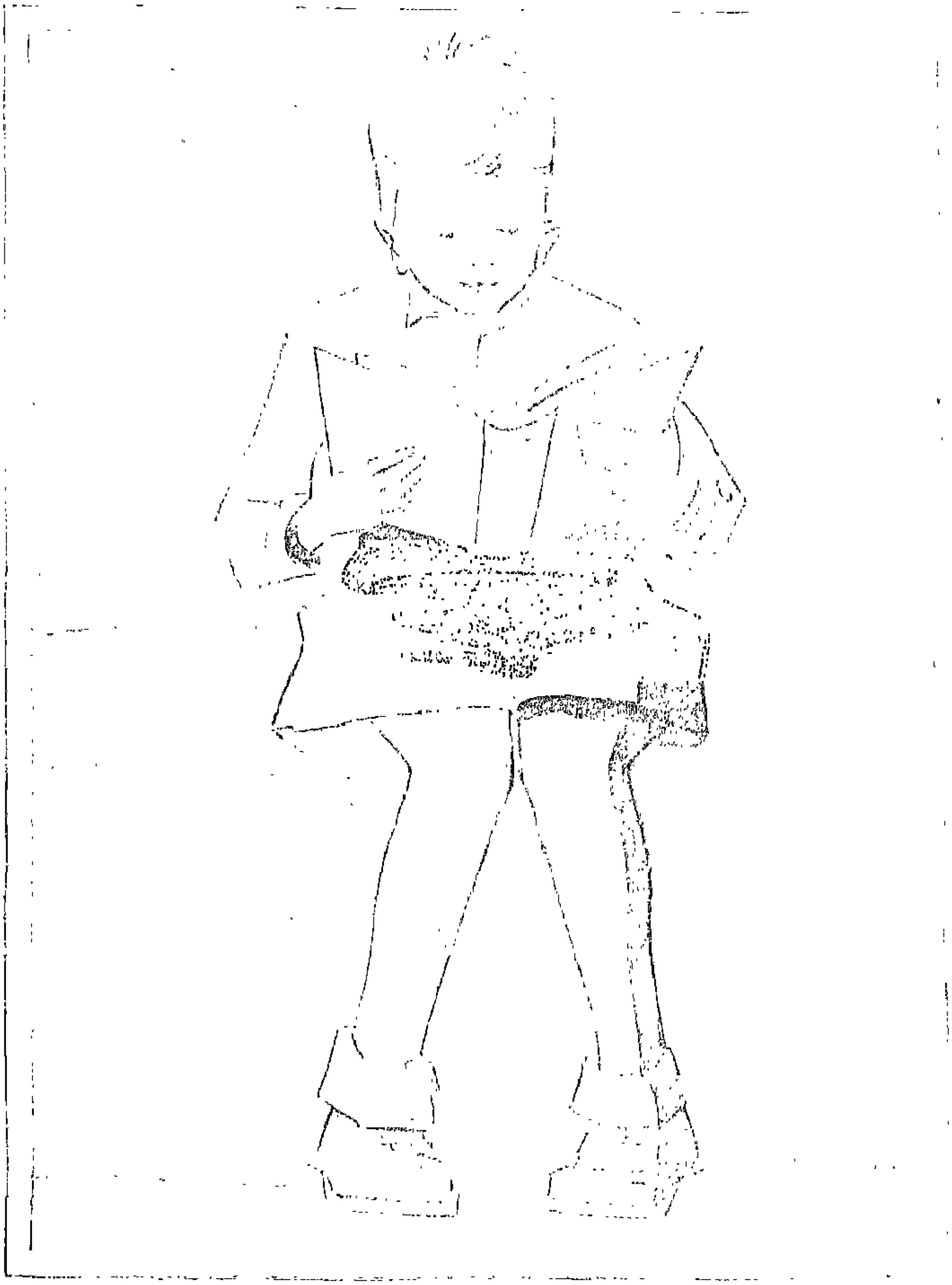


PLATE XIV

MEMORY CHARACTER SKETCH

This sketch was drawn to express the character of the model, although attention was also paid to correct proportion. All memory drawing should aim at expressing the personality of the subject, and for this reason, there should be no rubbing out.

PLATE XV. MEMORY DRAWING—2

Plate XV has some memory sketches of the Berkshire Downs in autumn, the Fens in flood and the Swiss Alps in summer. I chose these places because, for various reasons, I am interested in them, and being interested made me want to draw them. I chose them also because of the difference in their structure.

The sketch of the Downs is of a particular spot. I remembered the strong even lines of ploughed field in front; I remembered the rounded hills with the white chalk gleaming through the grass, giving a wonderful opalescent quality to the colouring; and the rounded clumps of beech on top of the hills. I recalled my walks round the hill on the right, looking down into the valley at the farm with its warm coloured ricks and sheltering trees and green grass. I remembered the distant country.

The Fens were under water; the water creeping up to the farms, the gate posts just appearing, the tree trunks submerged, the stacks just going to be submerged—the effect of such vast stretches of land in this state has a peculiar fascination.

The Alps attract me partly because mountains are less familiar to me, but chiefly because of the peasant life and the colouring. The distant snowy mountains and the intense blue of the wide valley against the near green grass up which the woman is climbing with her basket full of food for the cattle is a panorama not easily forgotten.

I think we recall things in different ways. I do not visualise faces, although I can draw them from memory. I do it by recalling impressions of the whole figure, the personality and characteristic movements. But places which are of interest to me are so vivid that I am almost there. I can recall every part of a familiar house, every ledge and stair, every piece of furniture. I can see the gardens, the short grass, the long grass, the gravel, the paving-stones, the hedges, the trees, the stream and the flowers as they come. I can remember the colour and the atmosphere of less familiar places quite well, but not the details. To draw them, I should have to see them again and go laboriously over the details; to attempt to recall them would be an equally laborious process.

Most children like an outdoor life and are full of interest for their surroundings. Scouts and guides and people who like walking know them fairly thoroughly. The roads and lanes and rivers and woods are full of pleasant associations for them. Children who like geology and geography and outdoor life might find it useful and attractive to do bold landscape sketches from memory, recalling the characteristic formation of the landscape, the colour of the soil, the structure and form of the trees, the hedges or stone walls which divide the fields and the colouring of the various crops with perhaps a cottage of local stone. They might do a series of impressions of the country during the months of the year; e.g., a frosty morning when the sun is low; the sky green-blue, the ground and the roofs sparkling, the walls and ricks glowing warmly against the whiteness, the horses in their thick winter coats munching from their piles of hay: a spring morning when the trees and hedges are a purple-brown with a tinge of green, just beginning to burst; the earth turned up by the plough shining wet and sticky in the sun; the shadows full of colour.

There are endless things to think about—it is only a question of finding who is interested enough to want to think about and draw them.

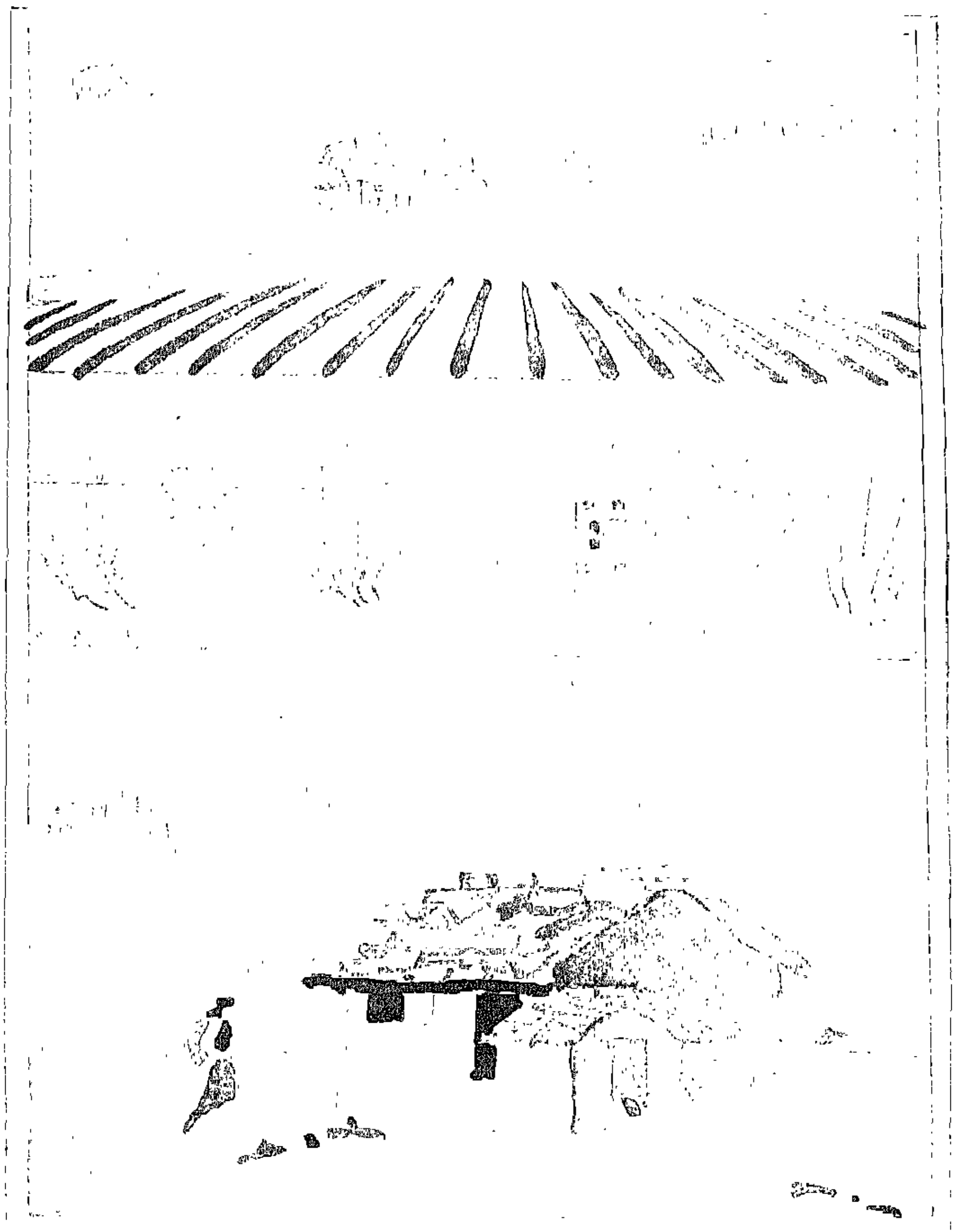


PLATE XV

THREE MEMORY SKETCHES

THE BERKSHIRE DOWNS
THE FENS IN FLOOD
A SWISS ALP

These three sketches are of entirely different subjects, yet in each case the atmosphere of the scene is vivid. It is essential to concentrate on those details of the scene which have left the clearest impression on the mind, thus producing vital, fresh work.

PLATE XVI. MEMORY DRAWING—3

Plate XVI contains some memory sketches of people doing things. This necessitates being interested in the people and watching, understanding and catching the rhythm of what is being done.

I like working in the old type of cowsheds —the sun on the rough white walls, giving them a faint pinky-purple tinge; the swallow going in and out to her nest; the yellow straw; the brown cows; the green hay; the warm purple-brown shadows; the steady rhythm of the milking. One night while I was working in one of these old sheds the baby was brought in and by the warm light of the lantern I could see him sitting up amongst the hay watching his father milking. The pleasant, natural atmosphere of these old sheds attracts me so that I can recall it all clearly.

The boy riding interests me because he has a good seat. Boy and pony are as one; there is no break in the movements. The way he sits, holds his hands, grips with his knees, his body moving with the pony, make an easy co-ordination. And the pony enjoys it—he hardly touches the ground as he trots.

The man mowing is making jerky movements. There is a stiffness and halt in the pose of his head, in his whole body and especially in the forward leg. He is forcing the machine with forward and backward jerks over grass which is too long for it.

If we can do the things and have watched them being done, it is easy to recall the action and make the sketch. Having made the same movements and watched them being done, they are understood thoroughly.

A child who likes dancing, or skating, or games, should be able to make sketches catching the rhythm of people doing these things. It is said that, unconsciously, we draw ourselves. There seems to be some truth in the statement and if so it should make the drawing of our own activities simple.

It is more difficult to follow an activity like hay cutting. The machine has to be understood. The co-ordination of the machine, the man and the horses has to be caught. One has to see how the hay falls and how the horses walk in relation to the lines of hay. The rhythmic lines of the freshly fallen hay are very beautiful. It is best to make a memory sketch of this kind fairly freely while the rhythm of it is fresh in mind. It is better to get the vitality and the co-ordination of the lines of action with free direct strokes and not to trouble much if the action is not always quite clear.

The sketches in Plate XVI are in perspective and show the movements clearly, but freely drawn they would have still more vitality.

Local activities are often very attractive. In the country there is ploughing, observing the construction of the plough and the strong movements over the heavy rough ground, noticing how the furrows are turned, revelling in the pleasant colours. There is hedging, wood cutting, timber hauling, the hay harvest, the corn harvest with fine large cart horses and wagons.

Fishing coves, docks, harbours, about which boys always know so much, suggest all kinds of subjects for natural, vital sketches.

This kind of memory drawing is useful in many ways; particularly, it encourages keen observation which one must have in order to think clearly.

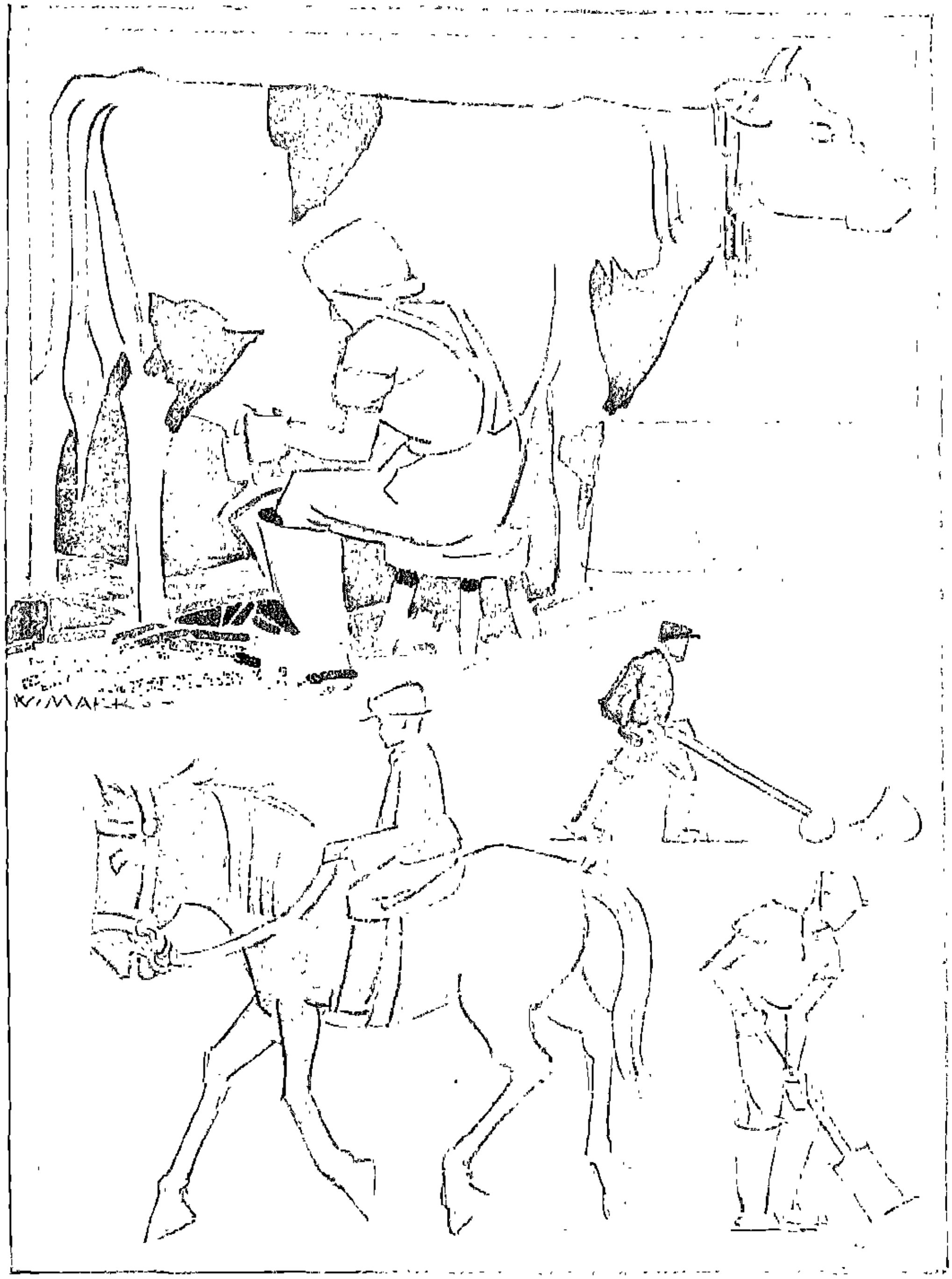


PLATE XVI

MEMORY LIFE SKETCHES

Life sketches from memory necessitate an interest in people and their activities. This type of sketching encourages a keen observation, for it is the quick eye which seizes on the essential details at once, thus ensuring life-like, vigorous drawing.

PLATE XVII. CREATIVE DRAWING—1

Plate XVII is an imaginative sketch for a poster advertising Switzerland in winter. My first visit in winter thrilled me so much that I want to go every year at that time. To make a poster of it, I decided I must create something which would arouse a similar enthusiasm.

I tried to think clearly all round the subject. I used my memory, recalling all the most vivid impressions of the first visit. I discovered that the point where I was always arrested, was the moment of stepping out of the stuffy little mountain railway into the fresh sparkling air and hearing the bells on the sleighs which were waiting for the passengers. I recalled the whole journey—the train running through the outskirts of Folkestone into the harbour; the rough passage; the Customs; the smoke of the French trains; the mountain railway circling in and out and over perilous bridges; the villages looking warm and brown against the white snow; arriving tired in the darkness; feeling the air and hearing the sleigh bells. I remembered the lights of the hotel. I thought about ski-ing and skating.

I arranged my impressions as clearly as possible and tried to work out different arrangements which really might make people want to go. Then I realised that I was working on one side of the question only. I remembered that they would have to think about going before they could do anything in the matter.

While I was thinking on both sides—of my own impressions and also of what would have to go on in the mind of someone else before he could get there—I began to think creatively and to know that I must sketch something which would bring those thoughts into action. Trying to think clearly all round the subject was a preparation for that flash of creative thinking which helped me to arrange my impressions in such a way that they might attract the attention, so as to carry the mind through the different stages of the journey to anticipate some of the pleasures at the other end. In all creative work, memory arranges the evidence. Trials and rejections are made and suddenly the creative thinking is begun.

Young children are considered sometimes to be very imaginative, but it is noticeable that older children often appear to have little imagination. They frequently think as someone else thinks, and in many cases are not learning to do things for themselves at all. We have to learn to exercise our minds in working things out for ourselves.

Creative thinking is most important. In all the activities of everyday life, there is the necessity for thinking clearly about the past and creatively about the future, in order to find out what to do.

This is why a child should discuss his drawings and come to realise how he is working. If he is doing reproductive work always, either from the actual objects or from memory, he should know that he may be doing very little, if any, of the kind of thinking which brings about all great achievements and which makes his own progress possible.

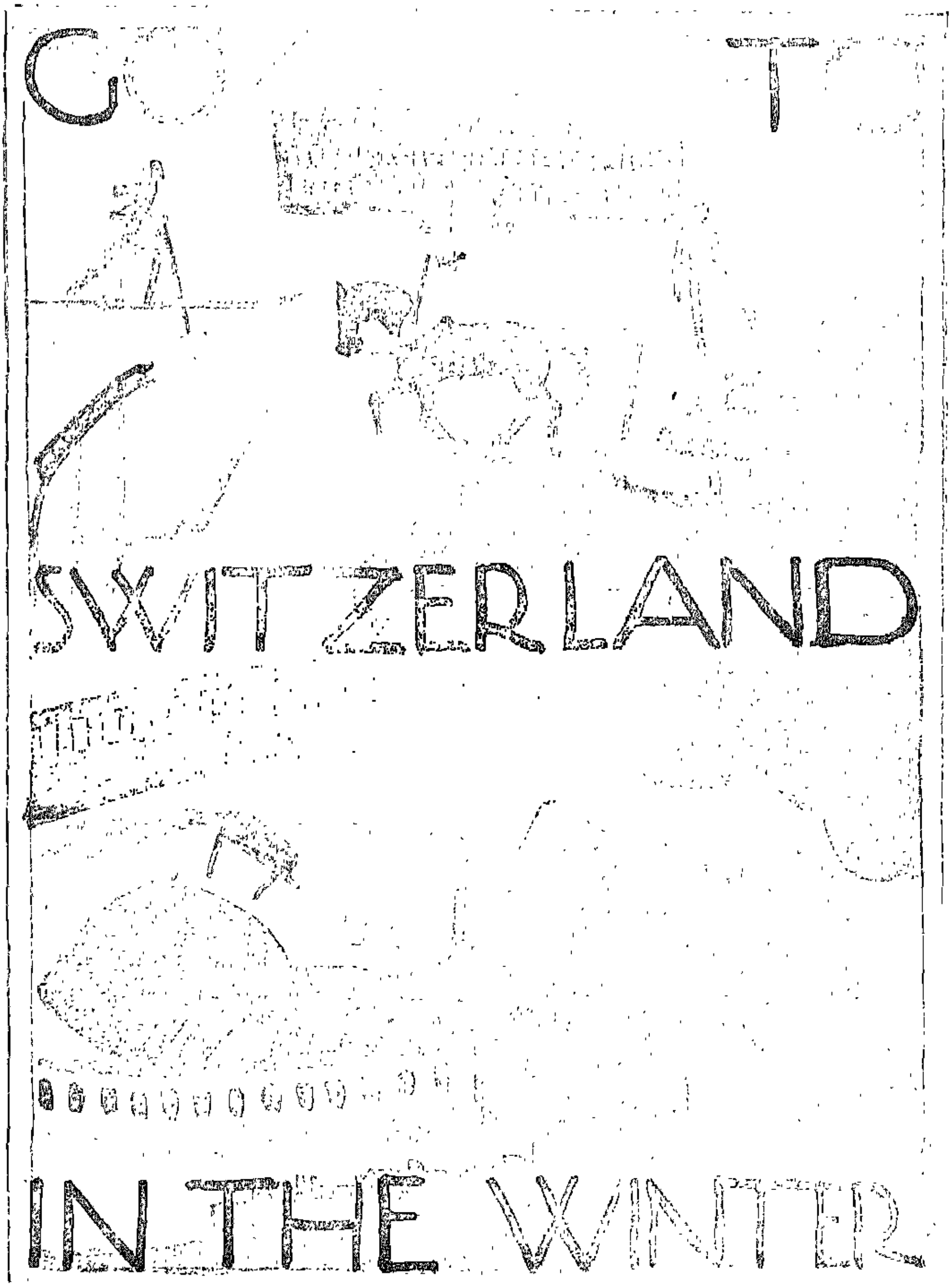


PLATE XVII

CREATIVE SKETCH FOR A POSTER

This poster was designed to stimulate interest and excite enthusiasm. In all poster work, creative thought is extremely important, for without originality of design the work will lack the striking, bold effect which attracts the attention and arouses the curiosity.

PLATE XVIII. CREATIVE DRAWING—2

I wanted to make an imaginative drawing which would attract the attention of and amuse a boy. Thinking on his side of the question, I chose a subject which was sure to be of interest to him, and specially to attract his attention I put an absurd situation to it.

I used my memory recalling the clothes the boy would wear, his position at the wicket, and the position of the wicket keeper and the spectators. I remembered how terrified one might be at finding oneself in such an awkward and foolish position in public and the type of boy who might feel like that about it. I used my imagination and exaggerated somewhat the appearance of the wicket keeper to him; horrified at him for doing such an impossible thing, but ready to catch the ball when it bounced off the edge of the spoon as it undoubtedly would do.

As in the poster of Switzerland, I thought out the various points all round the subject and gradually began to think creatively.

Creative drawing need not always be for making pictures. It can be in the form of sketches to help creative thinking in various directions. Perhaps it is museums and art schools that have given us the idea, somehow, that the end of drawing is the making of finished pictures. This may be why there are as many useless, so-called finished pictures, as books—probably more. Drawing is a natural means of expression and communication and it should be a means of intelligent expression. This can be only if we think about it clearly. When drawing is useful to children, when it is used in their own pursuits and interests, then mental development and expression go forward together, as they should.

If a child is made to draw things which do not attract him in the least simply to learn the principles of perspective or light and shade, the cycle of activity is arrested; he is turned in the wrong direction and progression is hindered. Drawing from objects or learning something of perspective are simple matters and he can understand the principles very rapidly should he need them to make the expression of his own interests more clear.

A girl who creates a new dress thinks very much about what she wants it for and what kind of dress would be suitable for that purpose. She thinks over her old ones and of other dresses, or visualises photographs of dresses which she has seen. She thinks over materials, textures, colours, lines. It is not realised, perhaps, that all this has to take place first if the result is to be successful. Suddenly she knows what will suit her exactly and puts all her energies into carrying out her scheme, creating other ideas as it goes along.

The same process of thinking goes on when a boy is working out a new way of doing a special piece of craft work. He thinks over the purpose of his work, he remembers all the ways he has seen it done before and the results of those ways. Thinking over all these facts, making trials and rejecting them, he gradually begins to think creatively and to find the solution.

The preparation of creative sketches and designs help so much in thinking over the performance of various crafts. They demonstrate the value of doing things in an orderly way and are a marvellous preparation for future work and for life generally.

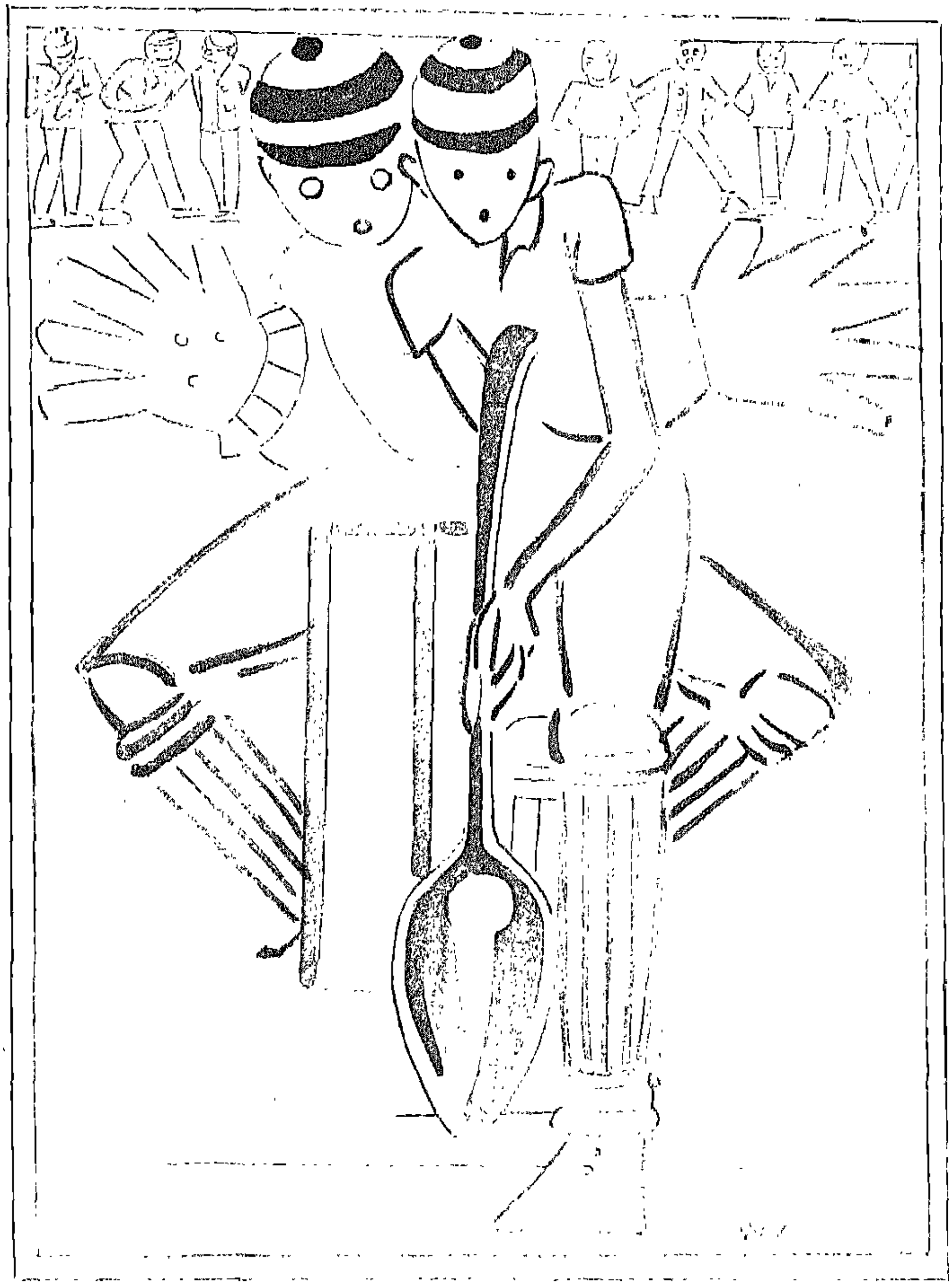


PLATE XVIII

A DREAM

In this Plate the use of creative thinking is fully shown. From an ordinary event a striking, amusing and original drawing has been evolved. Drawing should be a means of communication, and in order to develop this, creative thinking must be encouraged.

PLATE XIX. CREATIVE DRAWING—3

Plate XIX is an imaginative sketch of traffic in towns. I wanted to express in some way the growing power of mechanisation. In order that it should be appreciated generally, I chose a very common form of mechanisation—one which is very much in mind at the moment. I remembered that road traffic so often gives me an impression of being overpowering in speed and weight. Many people must have a similar sensation about it. I thought I should get more vitality by setting it diagonally across the paper. To attract attention, I chose the less usual point of view—from above. To give an impression of speed and power, I avoided concentrating on individual cars which would have attracted attention and destroyed the movement. My idea was for streamlines and simple light and shade to give the maximum of speed and weight.

Plates XVII, XVIII, and XIX were made for the purpose of discussing creative thinking, to work out the difference between drawing from objects and from memory and creative drawing.

Reproductive drawing may be on as high a level as creative drawing, and the best reproductive drawings necessitate a great deal of creative thinking, but as a rule it does not exercise the mind in the same way as purely creative work.

If drawing is used to help in planning and thinking out other subjects which are of greater personal interest, immediately it becomes useful, its principles seem easy and it helps the subject of interest considerably. This is a progressive way of working and a preparation for the way we work in everyday life, when everything has to be brought to bear on a subject to make it successful.

An interest in other subjects may act as a great stimulus for drawing. Acting and the production of plays has everything to stir up a desire to make sketches. We must realise that dresses and scenes and scenery are planned usually in this way, and that it helps us to think creatively about the costumes and colours that are wanted. Work like this gives opportunities for large and small sketches, for different mediums and for marvellous exercises in colour and vitality.

Creative sketching for dress designing, furniture designing, garden planning, building, are all attractive opportunities for using different mediums and various ways of working. And it is impossible to do it satisfactorily unless the colours are run on well, and the right mediums are used. All this becomes attractive as soon as it is done for a purpose.

If children are to follow and learn through their interests, it means that gradually they must discover how to plan and carry out their own work. If, however, this is the natural course of events, it does not appear either unusual or difficult.

Group work is stimulating and children can help each other considerably.

If they are working out their own interests actively, there should be all kinds of drawing in all kinds of mediums going on at the same time, so that although several may be working in specialised directions no one needs have a narrow outlook.

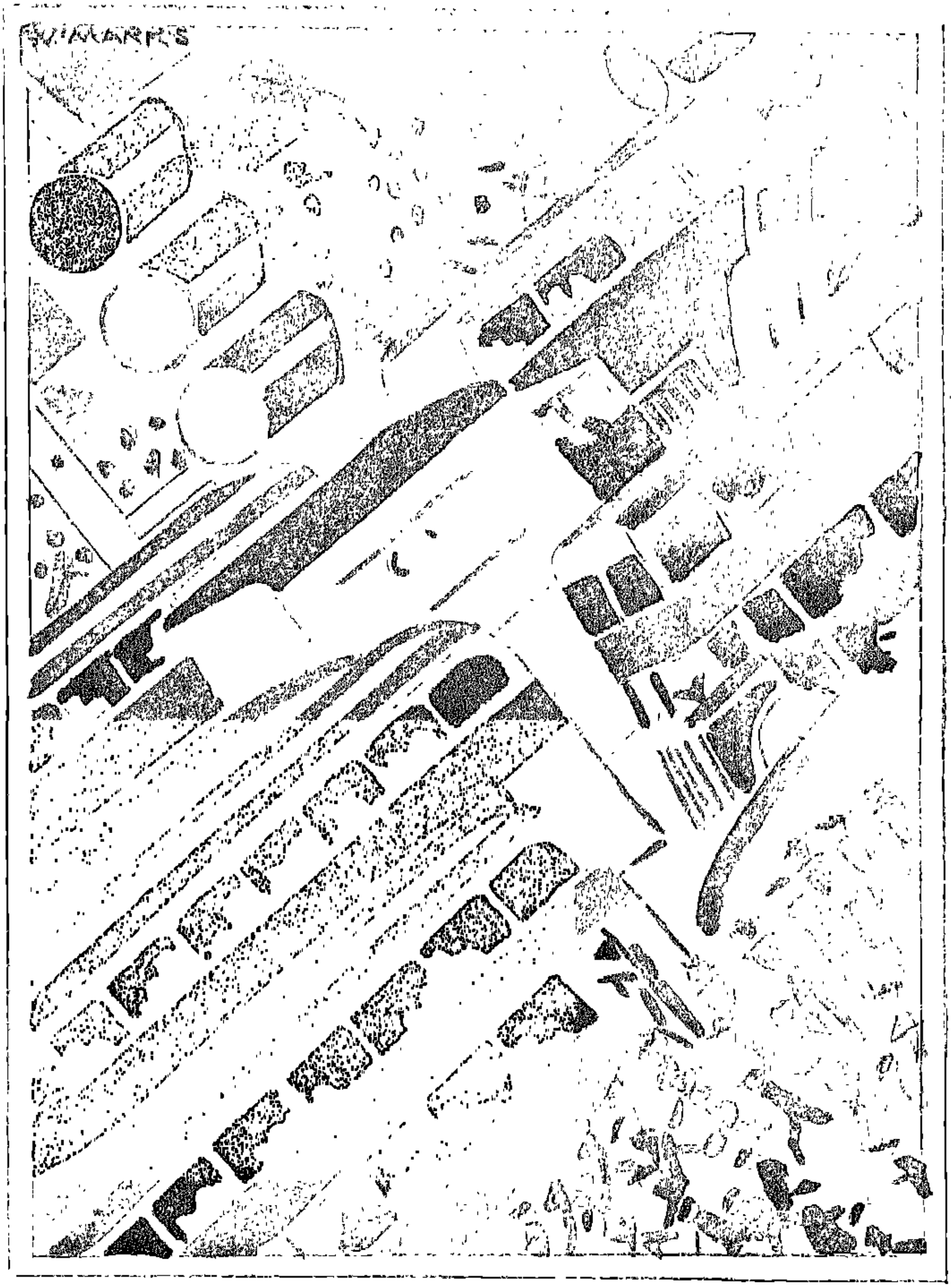


PLATE XIX

Traffic in Towns

This imaginative sketch was drawn to express the growing power of mechanisation. To create an impression of force and speed, no details were included. In order to arrest attention it was set across the page, and for the same reason was drawn from above.

PLATE XX. FREE EXPRESSION—I

Plate XX is a sketch of the shepherds receiving the message of the angel. The first has put his hand to his head; he is terrified, bewildered and helpless. The second is awestruck; he bends his ear listening intently, afraid lest he shall lose some further indication which may help him to understand what it all means. The third shepherd has received and understood the message; in spirit he is already at Bethlehem.

All the time I was drawing, I was thinking of one thing only—how would those three, probably very different personalities, receive the message? I did not think consciously about their appearance or anything else, so that I was free to express that one point of view, to concentrate on that entirely; which is why the lines are as they are and why the drawing looks as it does.

If I had been drawing a house from a particular position to show what it looked like, I should have had to think about the structure and proportion of the period and I should have made the drawing in proportion and perspective. Each line would have been drawn in relation to some other line. Not one would have been drawn freely.

If I had concentrated on the appearance of the shepherds I should have been thinking about anatomy and proportion and perspective and the dress of an eastern shepherd. I should not have been thinking freely on just one aspect and I could not have drawn freely.

The carvings and paintings and drawings from prehistoric times to the present time do not necessarily show stages of progression. They show that we have always been able to draw well, but that races and nations and groups think in different ways about things, and therefore draw differently.

The prehistoric artists who did the fine animal carvings and paintings were thinking about the appearance of the animals and drew *them as they saw them*.

The early Italian painters, who were working for the Church, did not draw people and buildings as they saw them because they were not giving their attention really to that, but to the stories which they were illustrating.

The later Italian school were working still in the cause of religion, but, as can be seen in the pictures, they were thinking quite as much about anatomy and perspective and form as about their apparent subject.

The French Impressionists were concentrating on the colours which they saw.

Seurat was working out the scientific relationship of colour, so that he put his colour on in spots, which fuse and give the desired effect when the picture is looked at from a distance.

The Cubists were thinking about form and the relation of one form to another which made them work out their subjects geometrically.

Recent artists have been thinking about various things. We may not always understand what they are thinking and therefore why their pictures look as they do, in the same way that we do not understand all the books which have been written. But personal opinions of their work do not alter in any way its intrinsic value, which is great. They have arrested our attention and made us think about what we do, and why we do it.

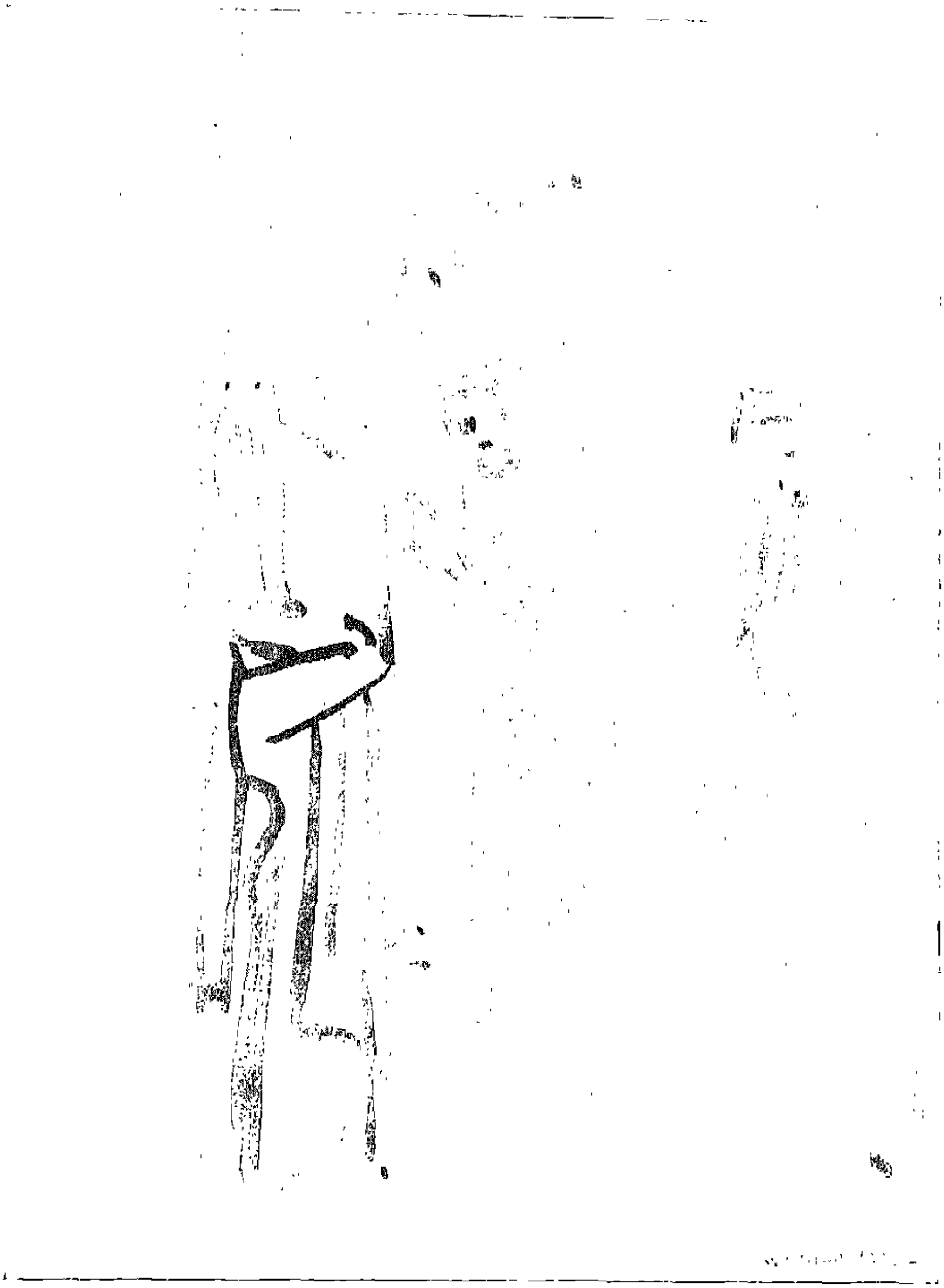


PLATE XX

FREE EXPRESSION

In this free drawing of the Three Shepherds receiving the message of the angel, proportion and anatomy have been ignored, the only aim being to express the varying emotions. For this reason the lines are pale and weak, indicating bewilderment and helplessness.

PLATE XXI. FREE EXPRESSION—2

At the moment it seems to be the fashion in most things to try to get down to fundamentals, to go to the root of the matter, to discover essentials, to analyse. In moderation this is a useful practice because it prevents us from going on with things for a long time without knowing in the least what we are doing.

This latter happens so continually because we have to spend such a long time doing what we are told—there is not much time left to think of *what* we are doing. But it is by action and thought together that we get a true understanding of things.

Plate XXI shows a carter leading his horse which is drawing a wagon load of wood on a wet, slippery road. I looked down on them from my window. The horse had to cope with a heavy load, not at all liking the slippery surface. The man was going steadily forward. I was attracted by the sombre, dignified colour; the strong rugged unity of the group; the slow powerful movements of both horse and man and the endurance which made them plod steadily through the wet, grey weather.

I was thinking of various aspects of the subject and not merely of one aspect, as was the case when drawing the shepherds.

The dark, rugged appearance and slow, powerful movements suggested the use of heavy, yet vigorous, lines and rich washes of tone.

The lines in Plate XX are faint and weak because I was thinking of the fear and helplessness of the shepherds and of the spiritual nature of the scene.

In both these sketches I wanted to express the *ideas* directly, freely and crudely.

If I had given all my attention to the actual appearance of the carter and his horse, I should have thought about the proportion of the lines and their relation to other lines, and, as far as possible, of all the parts as I saw them. But in the drawing the carter has no back to his neck; his feet are not real feet, although they go forward as they were meant to go; the hand that should hold the horse is not really there; the mouth of the horse is not drawn; the harness is merely indicated, and it is not fastened to the horse; there is no shaft to the cart, which is without construction.

Had I thought about all these things there would have been no opportunity for those free, rapid, heavy lines which are a direct communication of the vigour and weight of the group.

In both sketches (Plates XX and XXI) I have used the appropriate lines and tones to convey what I was thinking about.

If I had drawn the carter and his horse in detail with refined lines, it would have shown that I preferred refinement to reality, or else that I was incapable of appreciating rugged vigour.

On looking at a drawing or a picture it is essential to a proper understanding to try to imagine what the artist had in mind; what was his IDEA.

It is not sufficient to glance at a picture and then approve or disapprove. It can be as interesting to read a picture as it is to read a book.

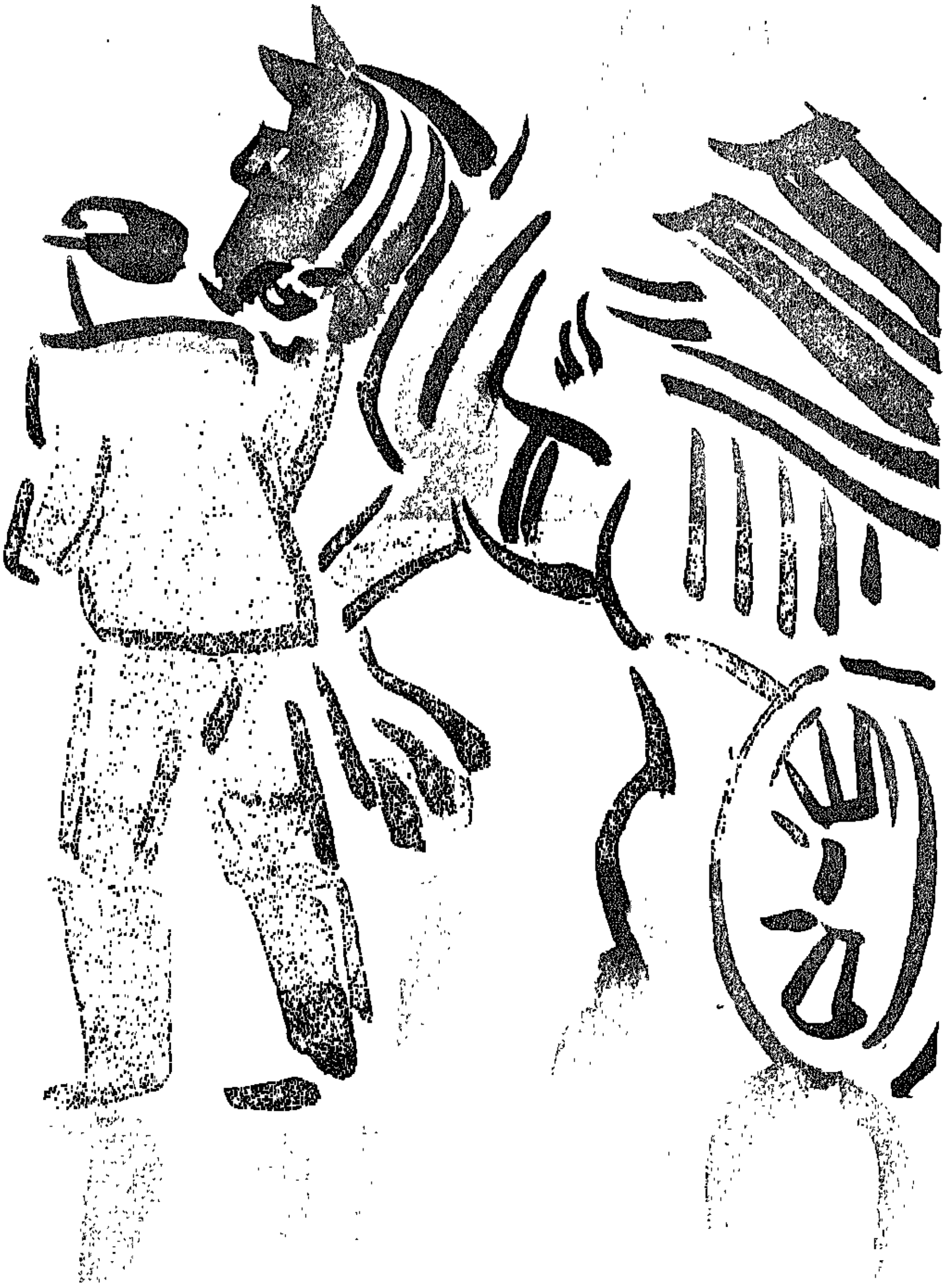


PLATE XXI

FREE EXPRESSION

This Plate has been drawn in free style, as was Plate XX, but here the lines are bold and vigorous expressing the solidity, the power, the determined purpose of the group. Notice the lack of detail—the only aim was to express the spirit of the group, to make a vital drawing.

PLATE XXII. FREE EXPRESSION—3

The movement towards free expression in children's drawing is perhaps one of the results of going to fundamentals and discovering things. It is part of the general movement towards freeing ourselves from methods and ways which limit our scope.

It is significant to think that the change is not really on the children's side, but it has had a beneficial effect, for it has allowed them to think in their own way instead of being told how to think. The change in aspect has shown that it is natural for very young children to think in such a way about things that they can be expressed only by free lines.

Teachers are now convinced that it is unnatural, unnecessary and requires far too great an effort for children to give all their attention to the appearance of things and to try to draw exactly what they see. Children think in somewhat the same way as the early Italian artists, who concentrated on the stories which they had to tell.

As the children develop their interests change; they think about things in different ways and they naturally, then, draw in other ways as well.

Plate XXII and XVI both show people doing things, but they are drawn differently because I was thinking of different things as I worked.

Plate XXII is a boy carrying hay. The right hand which would have been seen carrying the pike is not drawn. The left foot is not drawn. The boy is in proportion and perspective because I thought about that, but primarily I concentrated on the *movement.* Every line of the sketch—of the hay, the boy's head, his arm and body and legs—is going forward. The lines convey a direct and generous impression of the *movement.*

Plate XVI shows how all the parts appear in making the movements depicted, because when making those sketches, I was thinking about the parts and therefore they convey less sense of movement.

It is one thing to concentrate on movement and another to think out how the parts appear in making the movement—one thing to think about impressions of flowers, and another to think about the structure of the plant.

If the children are guided to realise this fact and work straightforwardly, they will draw things as they are thinking about them, sometimes quite freely, sometimes less freely, sometimes as they would appear from a particular point of view, according to the purpose.

Working in this way should give the confidence which comes in knowing what one is doing. It makes drawing a means of intelligent expression.

On the whole it seems more natural for children to think and express freely and to have the delight and scope which comes from it, but whenever the necessity arises for thinking in other ways, the expression must be different.

Free expression is not poor drawing and has no connection with it. A drawing is poor when it does not fulfil its purpose.

Writing a description of a sketch or picture is an easy way of discovering if it has expressed the artist's intention.

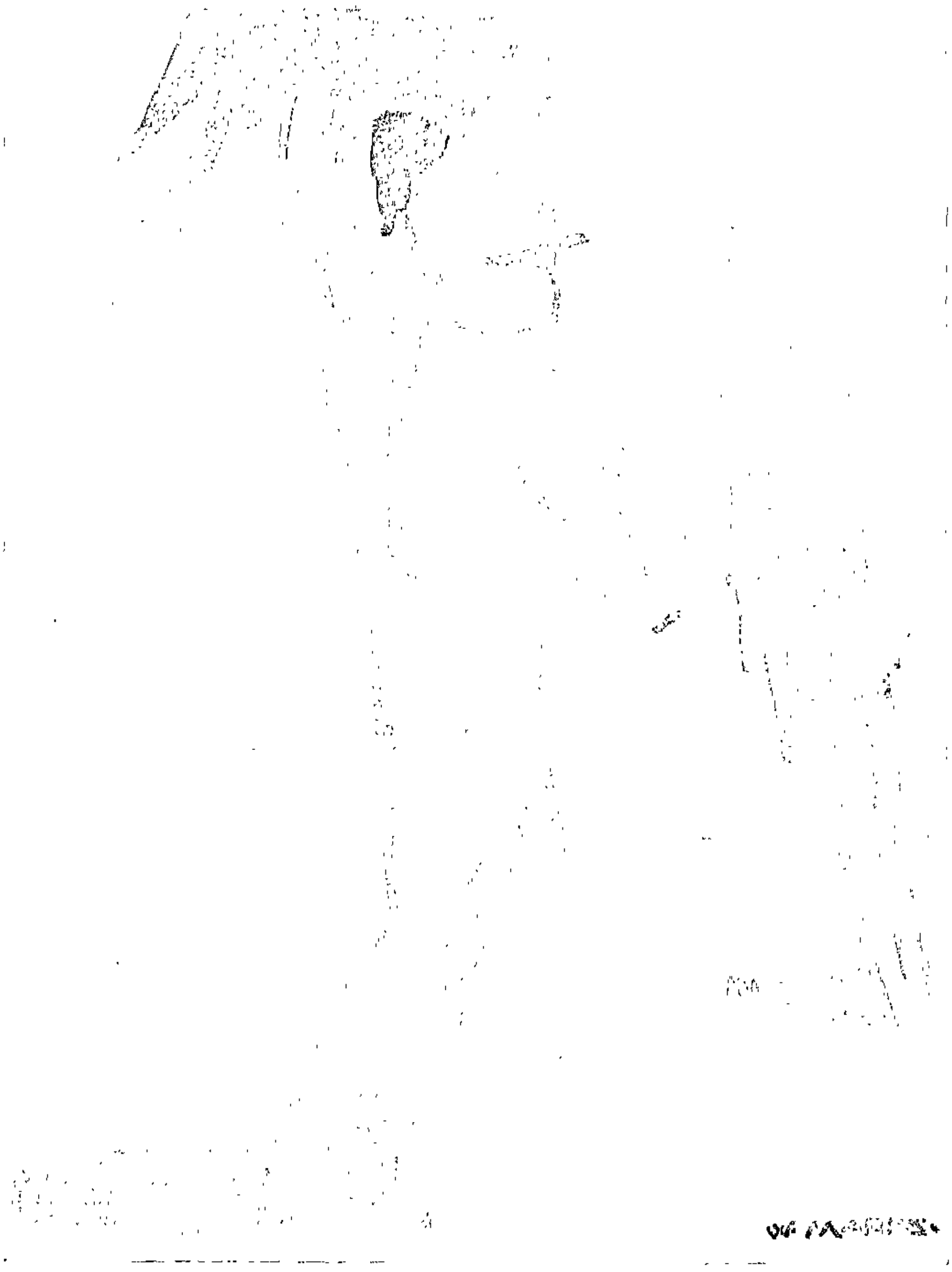


PLATE XXII

FAIRLY FREE EXPRESSION

This drawing of a boy carrying hay expresses the movement of the action. There is no detail—his right hand is not drawn, nor is his left foot, yet the sketch clearly conveys a feeling of movement and therefore fulfils the artist's aim.

PLATE XXIII. THE STUDY OF COLOUR

It is thrilling and delightful to look at and to think about the colour which objects reflect in sunlight and in other bright lights. And because these colours tell us about the nature and condition of the objects themselves, *we have to give them attention and* understand them.

Painting, working with brightly coloured materials, doing things in colour, draw attention to the phenomenon itself. The colours have to be chosen; this means that they are defined by name. They have to be handled and arranged to their greatest advantage, and to do this well, attention has to be given to their purity and brightness, to the effect of variation in the light in which they are seen, of variation in texture and the effect they have upon each other when they are placed side by side.

It is much easier to discover these things by working with intense, definite colours, rather than with weak, vague ones.

With the right pigments and some small folds of normal red, orange, yellow, green, blue and violet papers, anyone can begin to make most interesting discoveries and experiments.

The study becomes a thrilling search, for colour is precious—and good colour is not discovered very often.

By placing each fold of paper in turn against a white background and foreground so that one side catches a direct light from the left while the other is in shade, the changes can be seen in colour and tone which are caused by the difference in the intensity of the light. Orange, for example, will appear more yellow in the light and more brown in the shade.

The pigments to make these colours have to be chosen and mixed.

Actually a colour has to match in colour and in tone, but it is not easy to get the tones right—this comes only by practice. If the patch is right in colour but not in tone, it is all that can be expected at the beginning. It is better to accept this half truth than to get thick, dirty colour in the endeavour to match the tone.

If a pool of colour does not mix as it should and it begins to look dull and dirty, the mixing must be begun all over again.

If the colour on the dark side of each fold of coloured paper is matched first, by the time the last one is finished the first will be dry, and the colour on the light side can then be run on.

As a rule, things are done several times before they are realised.

Simple objects in normal colours give the same experiences of colour but stimulate fresh interest.

The lemon and orange in Plate XXIII are made more interesting and more easy to do because the one is cut in half and the other is more than half-peeled.

The idea in studying from these objects is not to paint a lemon or an orange, but to study colour, and the cutting and peeling give several small coloured patches, which are far more interesting to see and more possible to match than is one large uninteresting area.

Each section of the top of the lemon, each pip, each patch where the skin has been torn from the orange in peeling it, has to be matched and run on individually with as much care as the attractive colour of the peel.

Some of these patches are one flat colour, some of the sections in the lemon blend and grade from light yellow-green to dark blue-green. However small the area, the colour must be run on wet.

If each patch of colour is looked at and matched and run on carefully, the printing becomes a simple matter.

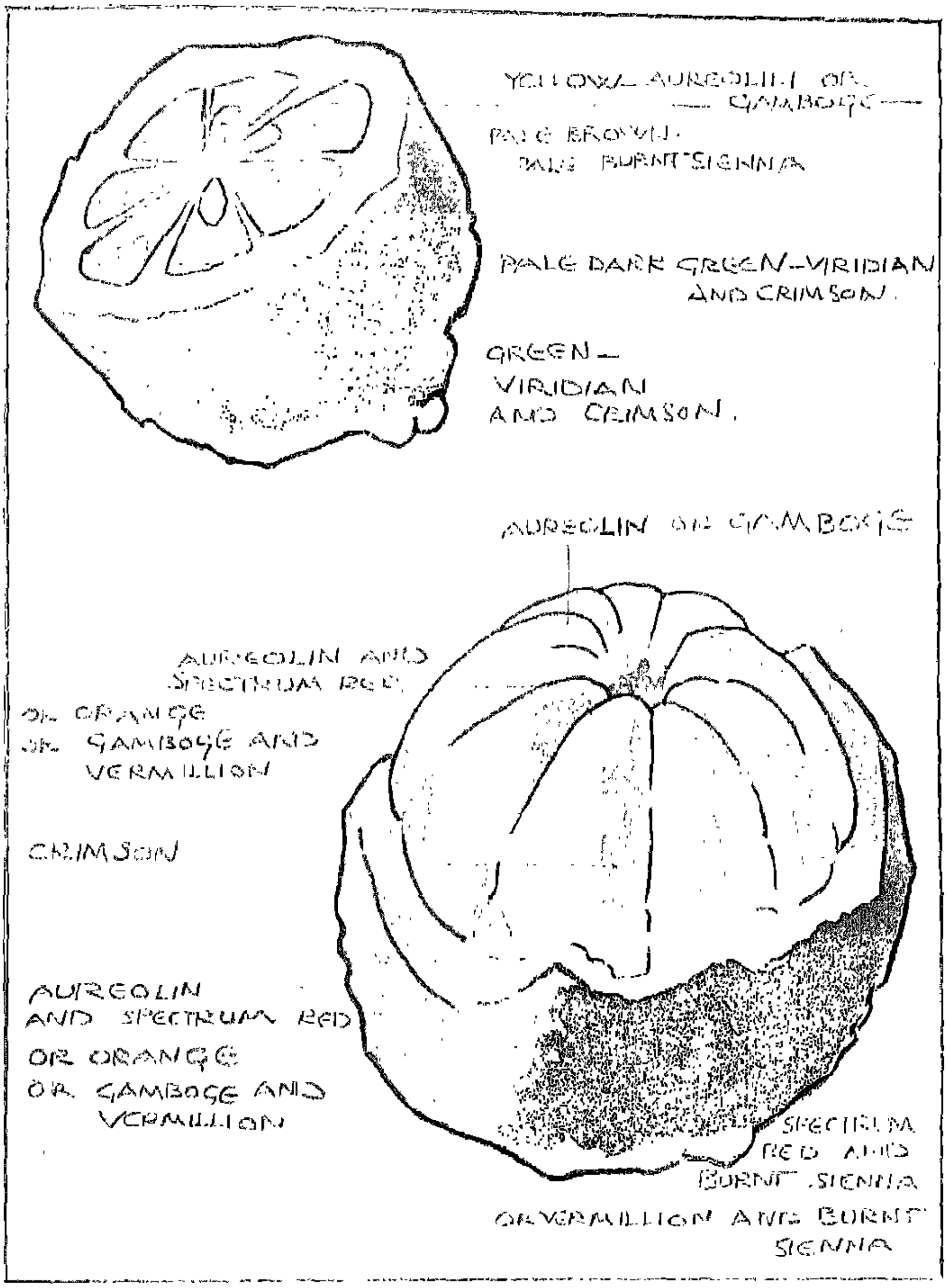


PLATE XXIII

THE STUDY OF COLOUR

The study of colour is fascinating and simple examples such as those afforded by an orange and lemon give ample opportunity for experimenting with colour.

PLATE XXIV. DRAWING FROM LIFE—FIGURE

Careful reproductive drawing is useful in many ways. It is interesting to reproduce good colour, structure and pose; it is necessary for science and for scientific work of various kinds. But, like talking, drawing is a means of expression and for many purposes, it is not necessary to describe minutely and accurately every object to which reference is made. Working continually from objects often creates the impression that no drawing is right unless it represents the object exactly as it is seen.

Drawing of this kind may produce a false conscientiousness, a scrupulous necessity for copying lines and tones exactly as they are seen in photographs produced by a camera. Too much reproductive drawing can prevent freedom of expression and be disastrous.

Some children may do careful reproductive drawing naturally, and for some purposes it may be necessary to do this, but it is preferable that a child should draw fairly freely and use the model for reference, rather than for slavishly copying lines and tones.

It seems reasonable for everyone to give a little time to figure work in order to overcome or prevent the general belief that it is difficult, and also to give time for observation and recognition of normal structure and pose.

It will be found from observation that in the adult the head measures about seven-and-a-half times into the total height, and a line through the broader part of the hips marks about one half of the figure. In a child the head is larger in proportion to the total height.

The head is broadest just above the eyes. The neck is slender and the head set forward. In the male the figure tapers downwards from the shoulders. The tips of the fingers reach a little below the half of the upper bone of the leg. The muscles on the outer side of the lower leg are higher than on the inside. The ankle bone is higher inside than outside.

In the normal standing position the head is up, the shoulders down, the waist in, and the whole figure slightly forward.

It is artificial to make ideal standards of proportion and everyone is more or less familiar with normal structure and pose. But looking for these points and thinking about them helps to create individual standards and arouses a desire to keep them.

It upsets the balance of a person to slouch and keep the head down and the waist out. Habitual neglect of pose and proportion ruins the figure.

The movements in walking and running are forward from the hips.

Some children like drawing from a given pose. Others may prefer to pose their own model and to work in small groups, where each one can see clearly from the position he prefers. Others may like to draw people at their work and to move about from one model to another.

An attractive model and bright colours arouse the desire to work. Nervousness and laziness which prevent a beginning may be overcome by using different and more interesting materials.

It can be helpful and stimulating to write by the side of the sketch what was attempted and what actually has been done.

A paper should be covered with experimental sketches.

It is interesting to work on papers of different colours and tones and to use all kinds of mediums.

A drawing will often show the desirability for a change of medium or for the necessity for using a particular one.

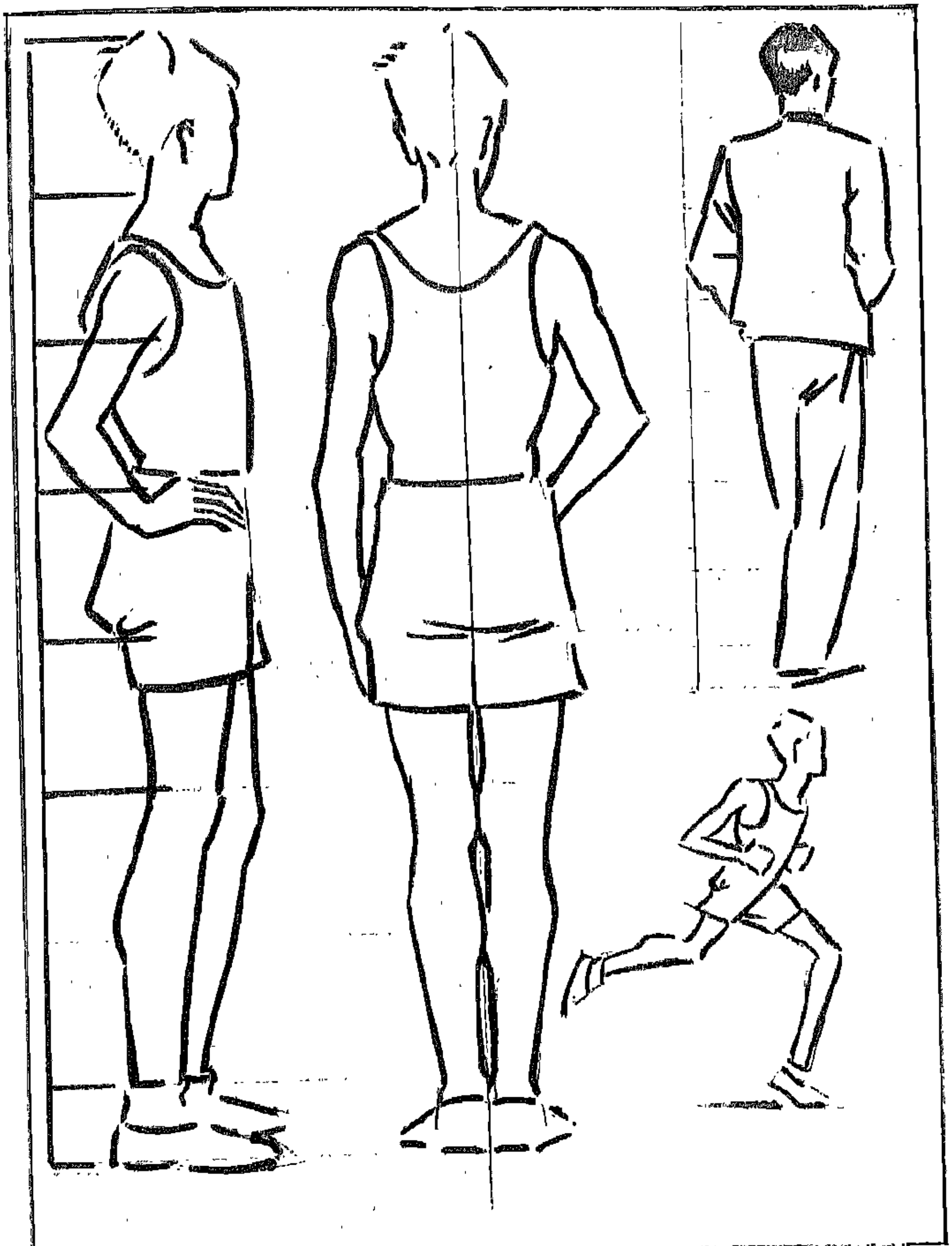


PLATE XXIV

Drawing From Life—Figure

Figure drawing is not so difficult as is popularly supposed. The sketches in the above Plate show the main proportions of the body and also the balance and position of limbs in movement. This kind of study encourages good posture in pupils.

PLATE XXV. DRAWING FROM LIFE—QUICK SKETCHING

Quick sketches encourage thinking about living, moving people, which is far more intelligent and interesting than drawing by copying lines and tones. There are in it, too, those elements of change, quick action, excitement and fun, which appeal to the alert, active mind.

Children like change and interesting, amusing incidents. Quick sketching gives opportunities for all that. It is more suitable for a child's way of thinking than long studies from models.

It encourages a lively observation of essentials and decisive thinking and drawing, for it is not possible to be half asleep and do quick sketches at the same time.

A brush or a pen is a medium with which there can be no question of indicision or alteration. Pen and brush might well be more generally used. They are mediums which usually appeal to children. The results are definite and they do not easily become rubbed and dirty.

Quick sketches usually depict the most interesting poses, when the figure is going about its business or play in a natural and unselfconscious manner.

It is not very difficult to make a sketch of someone reading. The model is easily referred to as often as necessary. It is not so easy to draw a boy kicking a football, which means watching and waiting and remembering. But with the habit of thinking about the person and not about outlines, whether the figure is in repose or action, the sketch is made from a more or less similar point of view.

Usually in this kind of drawing, some pose or action or effect of colour catches the eye and is considered interesting to draw. Therefore, when children do it, they have to learn to work for themselves and discover their own interests.

In the sketches illustrated on Plate XXV I was attracted (*a*) by the easy way in which the boy was lying in the deck chair and the strong clasp of the hand on his leg; (*b*) by the contrast of the other figure in the deck chair which was not tense and alert like the boy, but relaxed and resting.

The man lifting a sack is making a pause to regain his balance before hoisting it over his shoulder.

It interested me to try to seize and express just these points, but it seems to be a mistake to tell people what to think about and what to draw. Everyone is interested in different points of view and should be allowed and encouraged to find and express them. Normal children are on the right lines, although they may want a little encouragement to action.

It does not matter whether a sketch is in perspective or free. It seems necessary to think carefully before interfering with a way of thinking and working. It is more reasonable to encourage a child to express his own interests and to try to understand them before making any suggestion with regard to them.

Difficulties can be cleared away, but people should be allowed to develop on their own lines and the claims of individuality should be respected.

Rapid sketches usually produce the most attractive results; something which has life, something entirely different and quite removed from the often laboured results of more tedious drawing.

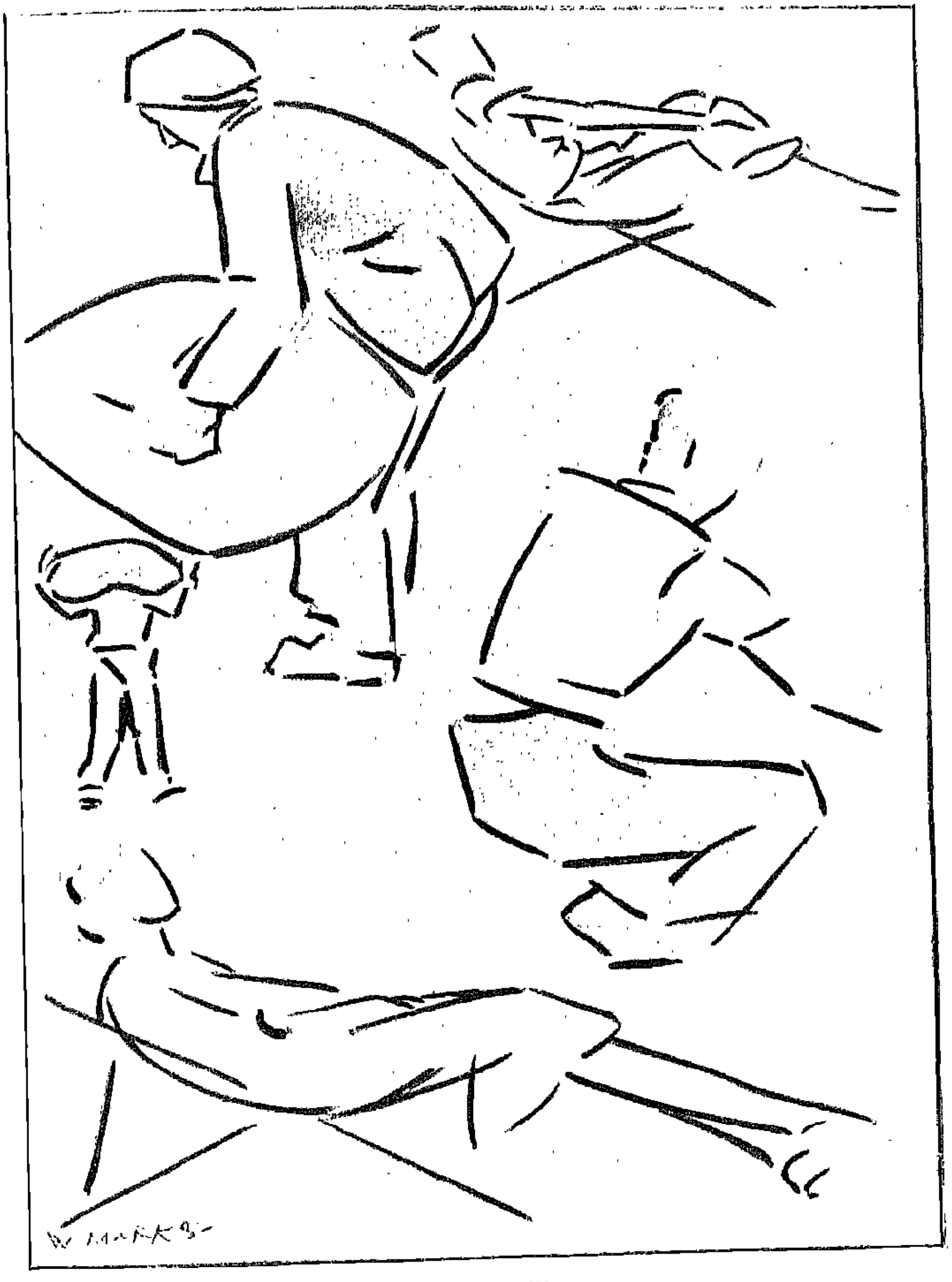


PLATE XXV

FIGURE DRAWING

Rapid life sketches should concentrate on the production of movement and vitality. They encourage a quick observation as well as a quick pencil, and drawings of this character may be either free or in perspective.

PLATE XXVI. VITALITY

The sketches in Plate XXVI show a boy climbing over a wall; children playing leap-frog and boys fighting; a boy who has flung himself down to look in a pond—all subjects with vitality in them.

I could see that vitality. It attracted me greatly. I like to see a dog tearing over the Downs or a foal galloping round a field.

The vitality is expressed by catching and then drawing the essentials with a few rapid strokes.

The original work of all children should be full of vitality because they themselves are full of it. Young children's drawings show it in every stroke when they are working freely.

It can be crushed by lack of encouragement as well as by repression. It is very easy to drift into more lazy ways of thinking and more dull ways of drawing.

But anything which takes the life from things—work which is too difficult, or too uninteresting, subjects which offer no opportunities and which repress this element of vitality—must be unnatural and wrong.

For some people, expressing vitality in drawing is like learning to swim or taking a plunge, but it is so worth while and, once it is realised as possible, much more entertaining than almost any other subject.

There is a delightful feeling of boldness in the first dash into action as it were, in sketching a subject like someone dancing, or a horse trotting.

There is plenty of vitality in many subjects which are not necessarily in action, but people often seem to avoid a vital subject or else try to evade expressing its very essence.

Dirty colour, the habits of thinking and working undecidedly and slowly and of altering things again and again are all means of crushing vitality.

Certain colours and lines cannot convey it, and even a piece of vital work, if it is altered, cannot regain its first quality.

Too much may be demanded from a drawing. Simple direct work can convey far more than any number of muddled, useless strokes and colours.

A desire for perfection is often a great hindrance; even a desire to do one's best may be an obstruction, because it so often prevents the things which really matter from being done.

A great deal depends upon the spirit in which the work is done.

Writing and drawing are similar in many ways. One novelist may express himself clearly and carefully, yet not a word is arresting. Another introduces those qualities which express a vivid personality with strong direct touches. He describes a place or a room or a scene—and you are there, you are in it. He can carry you absorbed through closely written paragraphs of humdrum happenings. He sees vitality and can express with vitality. In a word, he is *vital*.

Criticism of a drawing at the wrong time often destroys its essential qualities, not because it is resented or unwanted, but because it is an interference with the swing and flow of activity.

When the work is finished there is no danger of this happening and constructive criticism can guide and inspire vitality.

It is when one is not thinking out what one is doing but working slowly and concentrating entirely on some trivialities of the moment that essential qualities and the things that matter are lost, and often they cannot be regained.

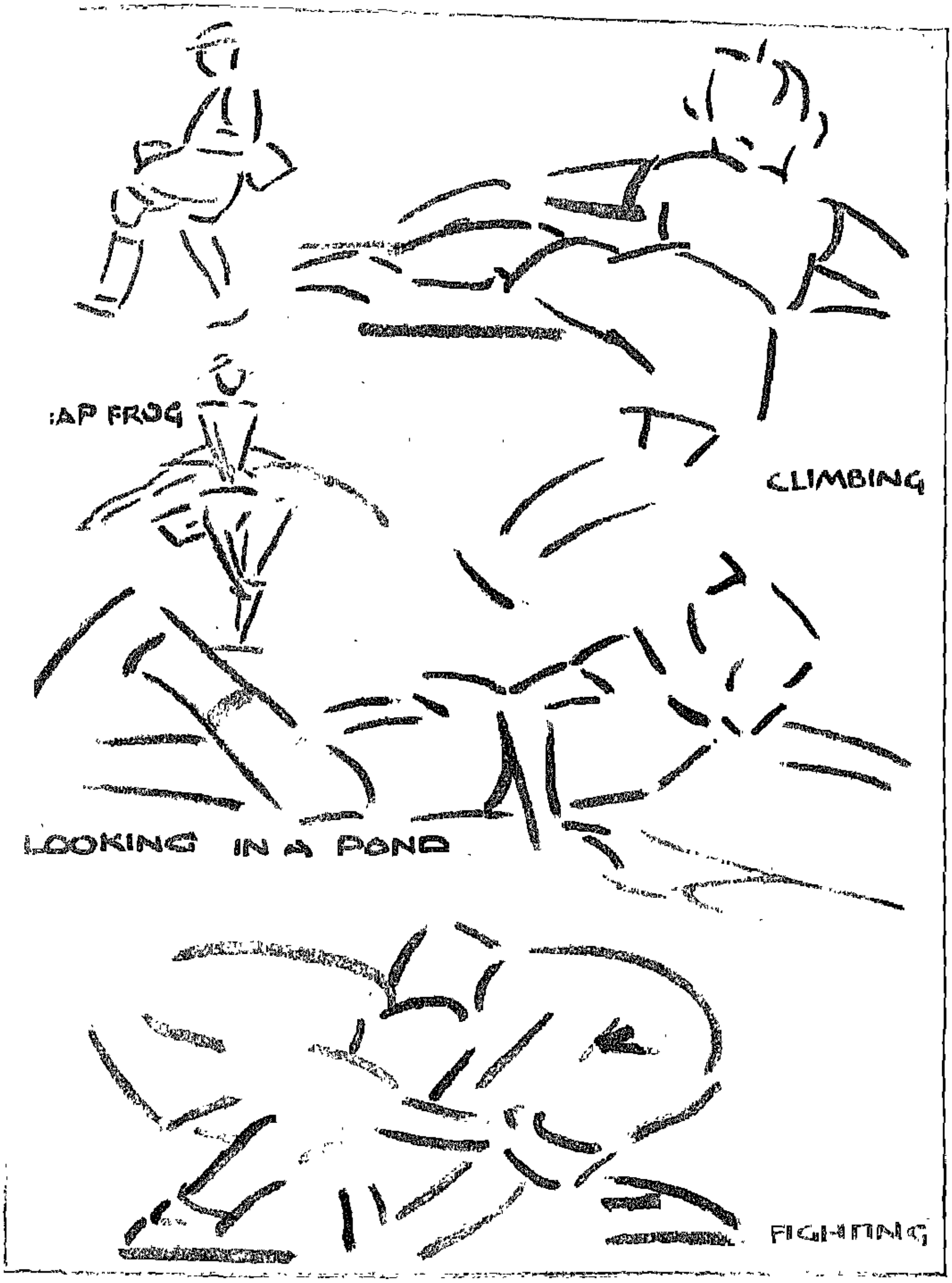


PLATE XXVI

VITALITY

This Plate consists of sketches all of which illustrate the vitality and movement of the actions depicted. Bold lines, clear thought, sure direct approach—all are necessary to produce the sketch which lives and which is real and expressive.

PLATE XXVII. DRAWING FROM LIFE—ANIMALS—I

Everyone does not want to draw animals, but they are certainly subjects for people who like them and spend time watching them.

There are so many forms of animal life. The structure is wonderful and marvellously adapted to the individual struggle for existence. The long neck of the giraffe makes him able to feed on leaves and shrubs which are out of reach of other animals. The bristles of the porcupine drive away enemies. Storks and cranes and herons can walk through slimy water and yet keep their plumage clean. Beavers have webbed feet for swimming and a flat tail which serves both as a rudder and to splash as a warning signal. The colour of animals is usually beautiful and frequently a means of protection from enemies.

These are some of the reasons why very careful descriptive drawings are made of animals, and their great vitality is one of the reasons for making free drawings of them.

From whatever aspect they are expressed it is impossible to draw them without knowing something about them.

They often have to be watched for a long time as they stand and walk and move about, before their structure and their normal pose are realised. It is impossible to catch essential characteristics without knowing a good deal about these things.

This is not a difficult study but a necessary one. To a great extent we are familiar with the normal proportions and colour of animals, but we have to give time to look for these points and to think over them, and to have some means of finding out how their structure and colouring have been adapted to circumstances.

Plate XXVII shows a shire mare. Her head is up; her ears are forward. The eye is set rather high in the head; the neck is strong. It is narrower at the head and gets broader as it joins the body. The shoulders are broad. The body slopes slightly upwards towards the tail. The legs are powerful. The normal pose is slightly forward. The build is essentially heavy and powerful.

By comparing different breeds, the characteristics of each are far more clearly emphasised. A suffolk is different both in structure and in colour from a shire. The clean, slim appearance of a hunter shows the general structure of a horse very clearly. The movements of the feet are particularly well seen.

It is far more difficult to follow the structure of some animals than others. That of the slim, elegant cat tribe is easy to see. That of the elephant and rhinoceros is far less apparent. The rhinoceros is heavily built; he moves slowly; his thick tough skin lies in great folds over his body—his parts are not easily realised. The structure of the elephant being hidden in a similar manner needs a great deal of keen observation before it is fully understood.

Watching and thinking and learning about animals gives a far more real appreciation of them; also, it takes the attention away from lines to realities.

Charcoal and wash are good mediums for large sketches. Pen and ink and wash are very useful for studies. If written notes are made by the side of the sketches, animal studies are found very useful for reference and for other work.

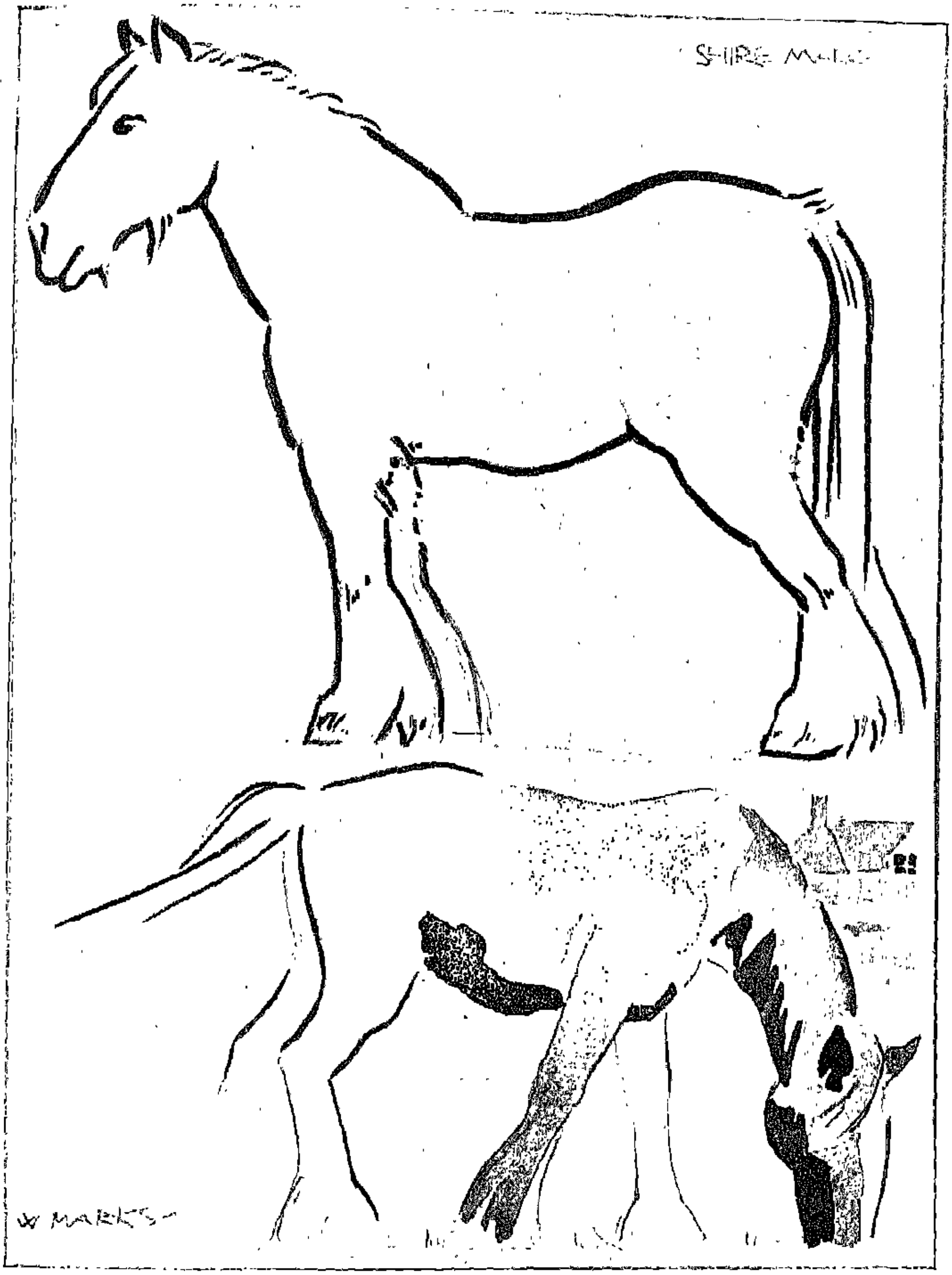


PLATE XXVII

ANIMALS

Animal forms are most interesting subjects for study. They afford opportunities for careful descriptive work, and for free, expressive sketches, at the same time enriching the knowledge of natural history, for it is essential to study their habits and varying structures.

PLATE XXVIII. DRAWING FROM LIFE—ANIMALS—2

Plate XXVIII has some animal sketches which are made from different aspects. The lamb was drawn to register its particularly characteristic attitude. The rabbits were done to study general appearances. The chicken was a model for matching and for running on colour.

Some children like to draw their favourite horse or animal in which they are interested from all points of view with no particular aim, but animals make good models for various definite purposes.

Horses move slowly when they are grazing, hence their structure and movements in walking can be seen easily.

Pigs and cows move slowly; pigs are attractive to draw and both animals give good practice for studying structure which is less obvious than in the horse.

The feathers of birds have beautiful pattern and rhythm. Hens, when they are roosting or resting on the straw in the daytime, are very still. They are simple in form and make pleasant, easy models for matching and for running on colour. The colouring of some of the brown chickens is very rich and beautiful, and with the exception of red, can all be matched with three pigments—burnt sienna, ultramarine, and yellow ochre.

The zebra and hedgehog are subjects for brushwork—for bold lines and fine lines and rhythm.

Young goats butting each other are amusing. The elephant, the bear and the penguin all have amusing ways which are easy to watch.

The cat tribe as a whole provides studies in elegance. A slim cat creeping through the grass with long, beautifully curved paws is an attractive sight. A tiger has similar movements, but is heavy and powerful, with a more majestic grace.

The tiger and the bear offer splendid examples of different ways of walking. The tiger moves forward. The bear lifts two legs on one side at a time, and has a shambling gait.

Kangaroos, young deer and lambs have hopping movements which are attractive to catch and draw.

It is particularly interesting to think about such points of view as these and to try to express them.

Animals are perfect objects for studying combinations of colour.

They are never-ending subjects for toys, for pictures for children's rooms, and for all kinds of needlework.

Really beautiful animal toys can be made so easily, and they give a purpose for studying the animals. They can be painted on wood, carefully or freely or conventionally. They can be done in soft materials, and also in coloured paper.

These are all things which have been done, but their true value lies in the individuality of treatment. The making and decorating of things is useful, and can be an easy means of approach to the drawing of animals by children who have had no desire for it before, or a great fear of beginning.

The ideal is for children to be sufficiently interested to chose their own work, and if only one child is doing animal studies, it at least makes others familiar with the fact and may lead to extended interest in the subject.

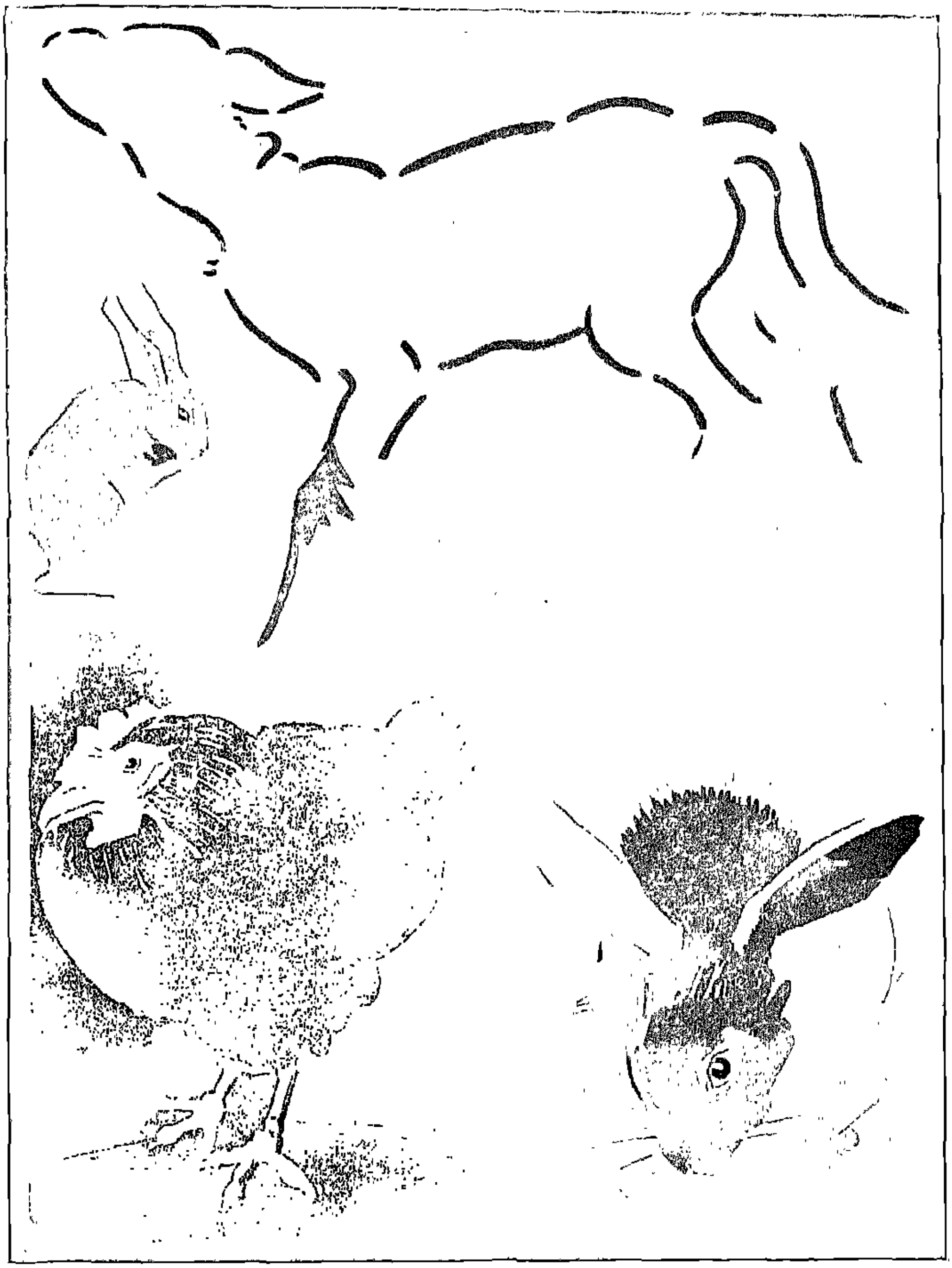


PLATE XXVIII

ANIMALS

The sketches on this Plate were drawn to illustrate various aspects of animal study. The lamb shows a characteristic attitude; the rabbits show general aspects, while the hen was used as a model for running on colour. There is an endless variety of work in animal study.

PLATE XXIX. FLOWERS

Groups of large flowers are subjects for fairly free pictorial drawing. Ordinarily, individual flowers are subjects for reproductive, descriptive drawing.

Some places have such a variety of flowers, it is delightful to become familiar with them. When it is possible to draw them as they grow, they are seen in their freshness and beauty. Their requirements of soil, temperature, and light; their associations with other forms of nature, can be discovered at the same time that they are drawn.

No one can remember exactly the grace with which a plant is growing, how it reaches to the light, is tucked away among leaves, or hangs over or grows in the stream. These are among the exquisite charms of flowers. They must be seen and watched to be appreciated.

The narcissi in Plate XXIX were growing in an orchard. They are drawn pictorially to give a general impression of the way they grow.

Colour, and delicate and wonderful structure are two of the attractions of flowers. Yet many drawings are done with dirty shading and others with dirty colour, both wrong in themselves besides choking and hiding any suggestion of structure that may be shown.

Colour and structure can be seen to an even greater advantage under a magnifying glass—and essential characteristics are seen sometimes more clearly when one plant is contrasted with another.

The delicate detail in flowers requires tools in good order—clean paints and water, a brush which comes to a good point, a pencil which is not too hard and unsympathetic and yet not too soft that it rubs and makes the work dirty, and a sharp blade to keep a pin point.

Some people like to work directly with a brush and this method can give the most beautiful effects. Whatever way the drawing is done, every wash should be direct.

The colour should be clean and thin. Petals and sepals and leaves often touch but are different in colour. This calls for a good deal of patience in working. One little patch of colour has to dry before the one that touches it is run on. To avoid spoiling the work by hurrying and letting the colours run into each other and to avoid wasting time, more than one sketch can be kept going at the same time.

However small a patch of colour, it must be run on wet. Even a spot should be put on wet; otherwise, the colour loses that purity and vitality which are essentials of the flower.

No flower can be represented exactly as it is seen. Many, like narcissi and snowdrops, have lines on their petals. To attempt any detail like that and at the same time to keep essential characteristics is impossible.

When drawings are being made from a scientific aspect, views are chosen which show the structure as clearly as possible. It is described most clearly by plans and elevations. Pictorial drawings may be necessary for purposes of recognition, but otherwise the drawings are diagrammatic. They are made to show the general growth of the parts, the actual shape of the leaves, petals and sepals, and the actual colour.

Accidents of structure or colour, or effects of light and shade only confuse the aim.

The lines should be direct and firm, preferably in ink, the colour clean and direct, the whole page arranged and lettered to make as clear a description of the plant as possible.

Pencil drawings with ink lettering are particularly unpleasant. Ink is more permament than pencil and makes the appearance of drawings which have written descriptions more uniform.

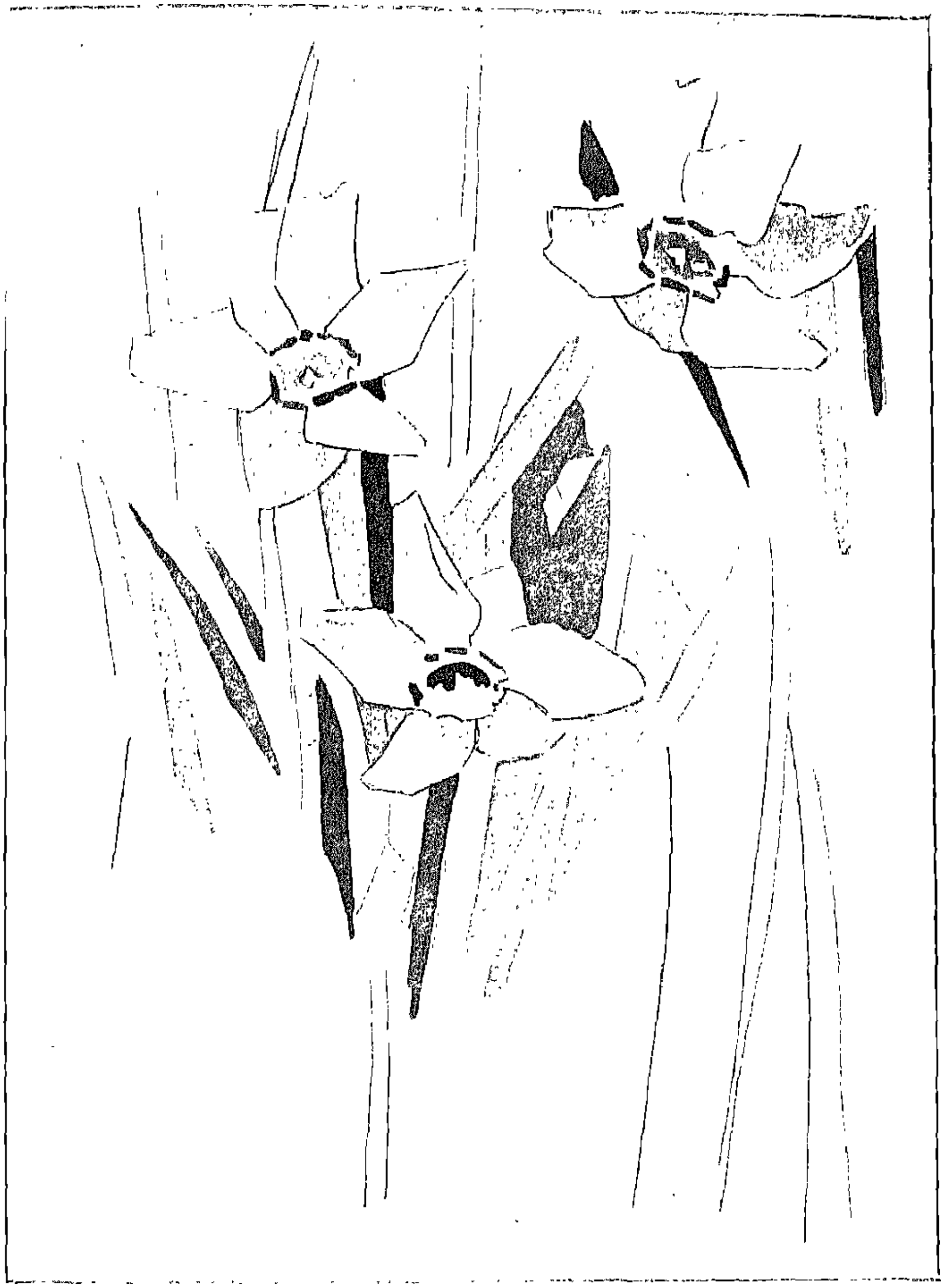


PLATE XXIX

FLOWERS

This group of narcissi has been drawn pictorially, and gives a general impression of the way in which these flowers grow. In all flower drawing the colour must be clear and pure in order to reproduce that vital freshness which is the charm of a flower.

PLATE XXX. TREES

Trees are most useful plants. In general they give shelter and food—wood for houses, furniture and tools; fruits, nuts and oils.

Individually they offer great interest. The wood of willow is less easily affected by water than most trees. They are often planted along a stream so that their large roots may keep the banks from being too much injured by the currents. The willow wood makes cricket bats and farm tools; paper is made from the white willow.

To look from a hill and to be able to recognise the trees which are growing round about gives to the onlooker an added interest in the landscape.

Winter is the best time to begin looking for trees. The structure of their bare branches can be seen easily and their pattern is often beautiful against the sky, showing the shapes distinctly.

The branches of the variety of willow shown in Plate XXX shoot upwards in gentle curves, slightly radiating from the trunk. The middle branch grows the highest and the others gradually less high. Their rhythmic, vital lines have a very particular character.

The elm in the drawing is fairly spreading. Its characteristic feature is its feathery network of branches rounded against the sky.

In summer, trees are recognised by their colour and shape, and the form of their foliage. In spring the foliage of willow is a yellow-green. Later in the year it appears more olive-green. It has a light quality with pointed and distinct feathery tips.

The foliage of some trees takes very definite forms. The sycamore is a tall, strong, spreading tree and the leaves grow in beautiful rounded clumps.

The beech is also a tall, spreading tree, but although the trunk and main branches are so strong, the foliage does not have the compact appearance of the sycamore. It it very grand, but has a lighter quality and the spreading shape is broken by feathery tips which grow upwards at the top of the tree and as they come down turn upwards with a slight curve.

If a tree is not recognised from a distance, it can be examined closely. It may be recognised by the shape or colour of the buds, by the catkins if it has any, by the shape of the leaves. Then it can be looked at again from a distance and its characteristics noticed.

It is a good plan to begin with some familiar tree, to find several examples and by comparing them, discover its normal growth, its normal shape and height and the characteristic arrangement of its branches; or, if it is summer, the characteristic form of its foliage. In time the essentials are easily grasped, and the tree becomes individual.

It takes some time to discover the real character of a tree. The observation is spread over the winter and the summer and the tree has to be thought about in its skeleton form and with its foliage at the same time.

Because trees have to be watched all the year round, it is most useful to make direct brush sketches or pen and wash sketches with short notes lettered on the sketch. In winter it is essential to show the normal shape and relative proportion—the way the branches grow from the main stem, the characteristic distribution of the branches, the general effect of the twigs as they are seen on the top and round the edges. In summer the colour, shape and form of the tree would be shown, and the essential quality of its foliage.

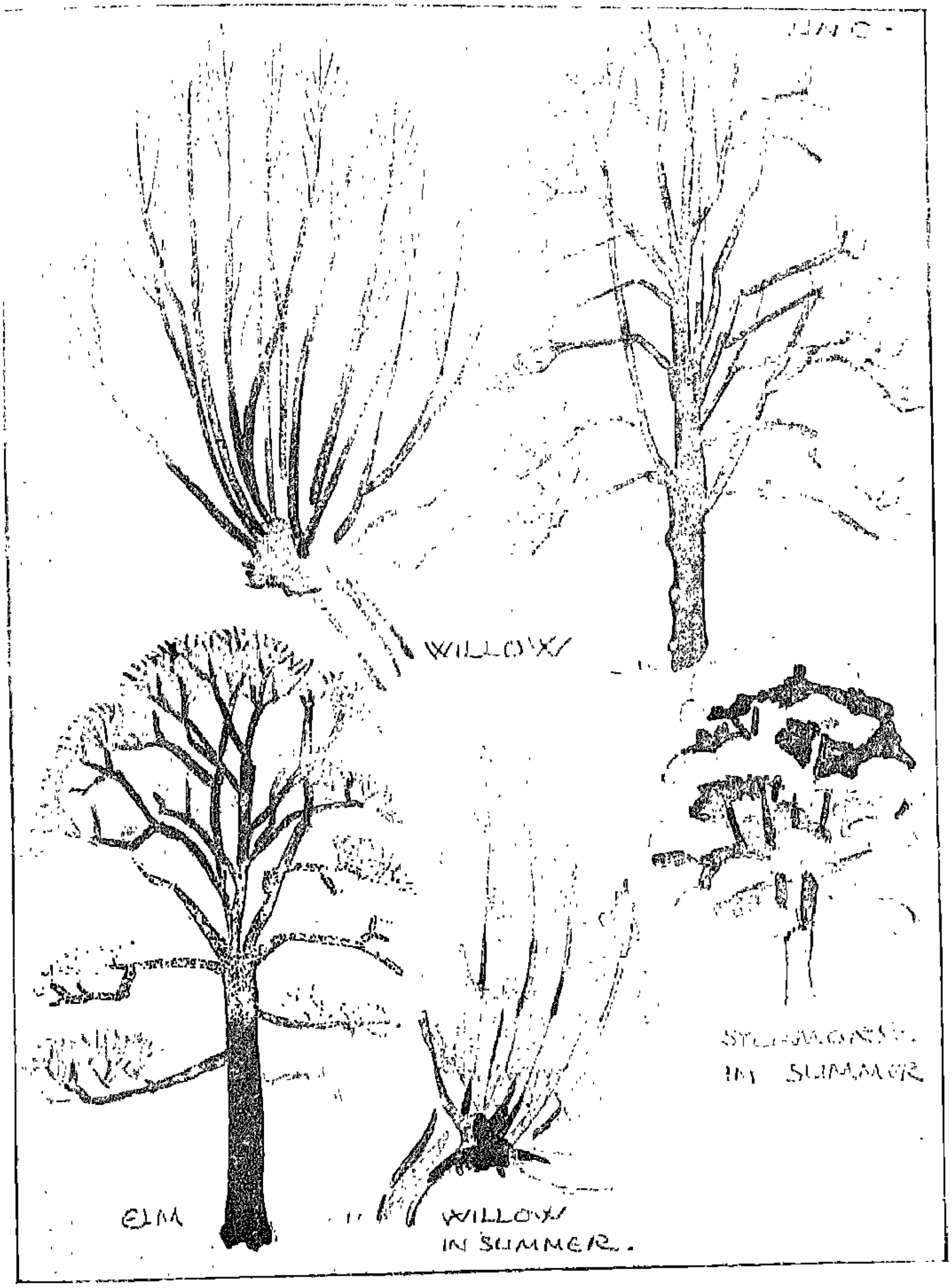


PLATE XXX

TREES

The study of trees is an important part of an artistic training. In winter the characteristic structures of the different trees can be seen easily, while in summer each tree is individualised and made recognisable by its distinctive foliage.

PLATE XXXI. ARCHITECTURAL SKETCHING

Towns and country villages are often rich in architectural gems which attract people from all over the world. Still more can be gained by drawing these things than by merely looking at them.

It is only by becoming familiar with good proportion—by working in it and thinking about it—that its value is realised.

Unless we give some time to think about these things they are not understood, and in ignorance, beautiful things will still be destroyed and ugly things will still be created.

Familiarity with good proportion makes poor work almost unbearable.

Before going out to sketch it is better to understand in plan and elevation and perspective the forms which are most common in building—the square prism, the triangular prism, the cylinder and the cube.

If the models are looked at and drawn for the purpose of understanding those principles of geometry and perspective which will make architectural sketching more easy, they immediately become interesting and can be understood quite easily.

The form of a cottage could be constructed with a square prism, a triangular prism, a cube and a cylinder, and when the form of a building is understood it is obvious which faces are parallel.

It should be possible to see at once which lines are parallel, which are above the eye and which below, and to find their vanishing points.

A cottage is a simple example to begin with. An elevation or a perspective can be drawn, but a perspective is usually found more attractive.

If it is possible, before beginning to work the building should be looked at from a distance and from a near point of view. The materials of the walls, the roof and the woodwork have to be seen. The roof may be of straw, tiles or slates. If it is of tiles or slates, their size and arrangement must be noted. If it is built of local stone it is interesting to examine it to see the colour and the size of the stones which have been used. The windows and the door may be set back very slightly at right angles. All such details have to be examined.

It is best to use the proper instruments when making architectural sketches, for then the lines are clean and decided and the structure can be carefully followed.

Light and shade help to explain the form, and working in light and shade gives a better realisation of the form. Dirty lines of pencil shading only confuse the work. Clean washes of simple flat tones are even more satisfactory than clean pencil line shading.

Details should be sketched separately and just as carefully as the main drawing, and the date and any points of interest might be noted on the sketch.

Plate XXXI shows a difficult example, because this type of window is difficult and tedious to draw, but it shows the value of sketching simply, and of refraining from overloading a drawing with detail. There is only a slight suggestion of the Cotswold stone, merely enough to show the type of stone, the size and the workmanship.

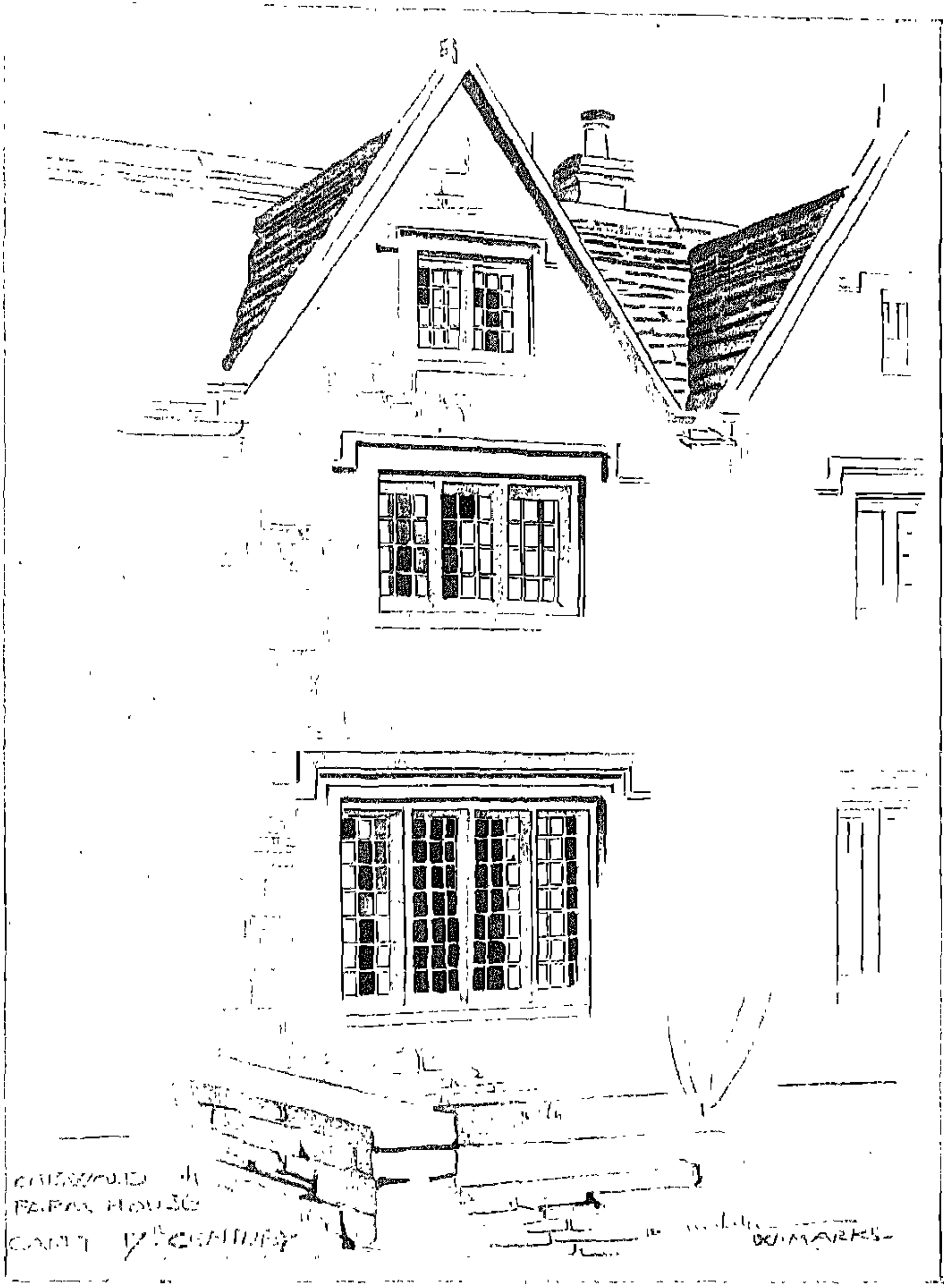


PLATE XXXI

ARCHITECTURE

Architectural drawing increases the knowledge of proportion, so that its true value may be realised. It is as well to make architectural sketches with the proper instruments so that the lines will be clean and decided.

PLATE XXXII. COMPOSITION—I

Composition is the choosing and arranging of parts so that each part will fulfil its purpose as well as possible. The purpose may be simple, for which a sketch would be sufficient, or it may be particularly important requiring a careful choice and relationship of the parts.

The pictures of the Italian School were pictorial bibles. They had a dignified and important purpose. They were painted to express the central beliefs of the church, simply and for everyone to see and understand.

The pictures for the churches and chapels were usually of a given size to fill a particular place. The subject matter with only slight variation was determined by the religious or particular purpose of the picture.

The figures as a whole were large, the size being controlled by the position from which they were to be seen. By placing the figures symmetrically, similar spaces and lines were repeated at precise intervals to give the effect of balance necessary to the dignity of the subject and to give the right relationship to the building.

The interest was maintained carefully, sometimes emphasised by lines leading directly to the centre of interest to give a complete unity, although little personal notes were frequently introduced as a slight relaxation. Horizontal lines were used to give steadying and balanced effects.

Colours were chosen, associated and repeated to give the required unity and harmony.

The relationship of the parts to each other and the place in which they were to be seen would be planned before the painting was begun. Certain arrangements were considered to be satisfactory, and therefore many pictures were composed on similar lines. Relationships are abstract, but they cannot be ignored, for the relationship of one thing to another is the key to the whole.

Leonardo da Vinci was much occupied with the idea that the working out of some mathematical formulae might give some beautiful arrangement producing a new and beautiful line.

All relations of lines and shapes and colours in architecture, furniture, gardening, pictures, are important not only in themselves but also for the success of the purpose.

Relationships have a definite influence—sometimes even a peculiar one. It can be felt in the arrangements and work of tribes and nations; people with different ways of thinking and living are interesting from this point of view.

Any arrangement is a composition, but every composition need not be formal. A rough sketch may fulfil its purpose but there may be no elements of balance in it.

The purpose of Plate XXXII was to tell a story which could be read quickly like a book. The drawing was made in a running fashion. Certain lines and spaces were roughly repeated at certain intervals with the intention of producing something of the evenness which is obtained in the arrangement of lines and spaces in writing.

It was possible to fulfil the purpose with freedom, but not without a certain repetition to give unity and balance.

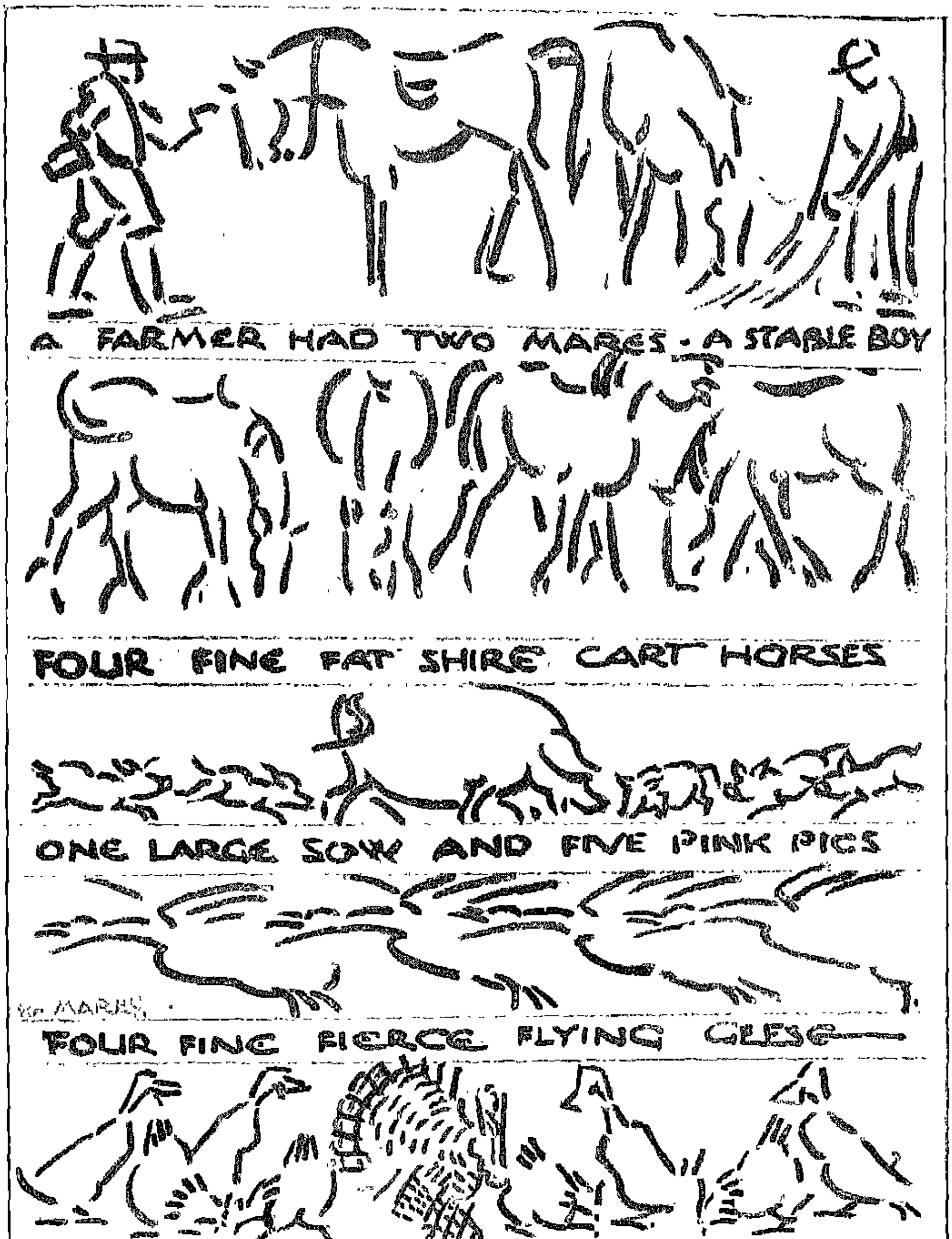

A FARMER HAD TWO MARES · A STABLE BOY
FOUR FINE FAT SHIRE CART HORSES
ONE LARGE SOW AND FIVE PINK PIGS
MARKS
FOUR FINE FIERCE FLYING GEESE—
ONE TURKEY FOUR DUCKS AND MANY CHICKENS

PLATE XXXII

COMPOSITION

This Plate gives an example of the choice and arrangement of parts in telling a story pictorially. Unity and balance are preserved by the repetition of certain lines and spaces.

PLATE XXXIII. COMPOSITION—2

Many modern posters and advertisements illustrate clearly the artist's capacity for thinking and the ability with which the materials have been used.

Amateur posters and notices frequently show an absence of these qualities indicating a lack of thought and practice in arrangement.

The teaching of composition often results in the frequent use of similar objects and the making of similar arrangements. There is little originality shown in working out the various problems.

As individuals, there should be individuality in purpose and, therefore, in the choice and arrangement of the parts.

If subjects were worked out for definite purposes and, when finished, were discussed or described in writing, the subject matter and the arrangement of the parts would be carefully thought over and the faults and merits would be realised.

It is helpful to ask the following questions when criticising work. Are the objects or parts which have been drawn really related to the purpose? Are they appropriate? Is there anything else which would express the purpose more vividly?

Are the proportions satisfactory? Is the size of the parts in proportion to the size of the picture and right for the position from which the work will be seen?

If the composition is to be formal, should not those shapes and spaces and colours be repeated and arranged evenly to give balance?

Are those little incidences and decorations necessary—do they take away from the dignity of the composition?

If it is to attract attention from a distance, why are the tones so faint?

If the colour is the chief attraction, why is it dull and dirty?

Thinking over even small sketches brings an understanding of what is being done, and of what can be done.

The purpose of Plate XXXIII was to express Modern Mechanisation. For this, the objects or parts of the picture had to show some aspect of modern life; it had to be hard, streamlined and balanced.

The aeroplane was drawn larger in proportion to the buildings to express its power over them. The blocks of the buildings were arranged and the lines ruled to give the balanced and hard streamlined aspect.

In practice compositions usually work themselves out.

In daily life we have to arrange things continually—many different kinds of things require thought and careful arrangement—and therefore we must know how to do it suitably.

Children who are not used to thinking about these things need not have the dreadful feeling of being asked to do something they feel incapable of doing. It is not necessary to begin the practice by arranging the figures in a drawing or a painting. A bowl of flowers can be arranged. They can be done every day. Needlework can be done in which figures and objects can be appliquéd in bright colours. Coloured paper is a very useful medium for early practice in composition. The colours are definite. If the forms are cut, they are definite, and the parts can be handled and arranged and rearranged. Any familiar craft will make an equally good means of approach.

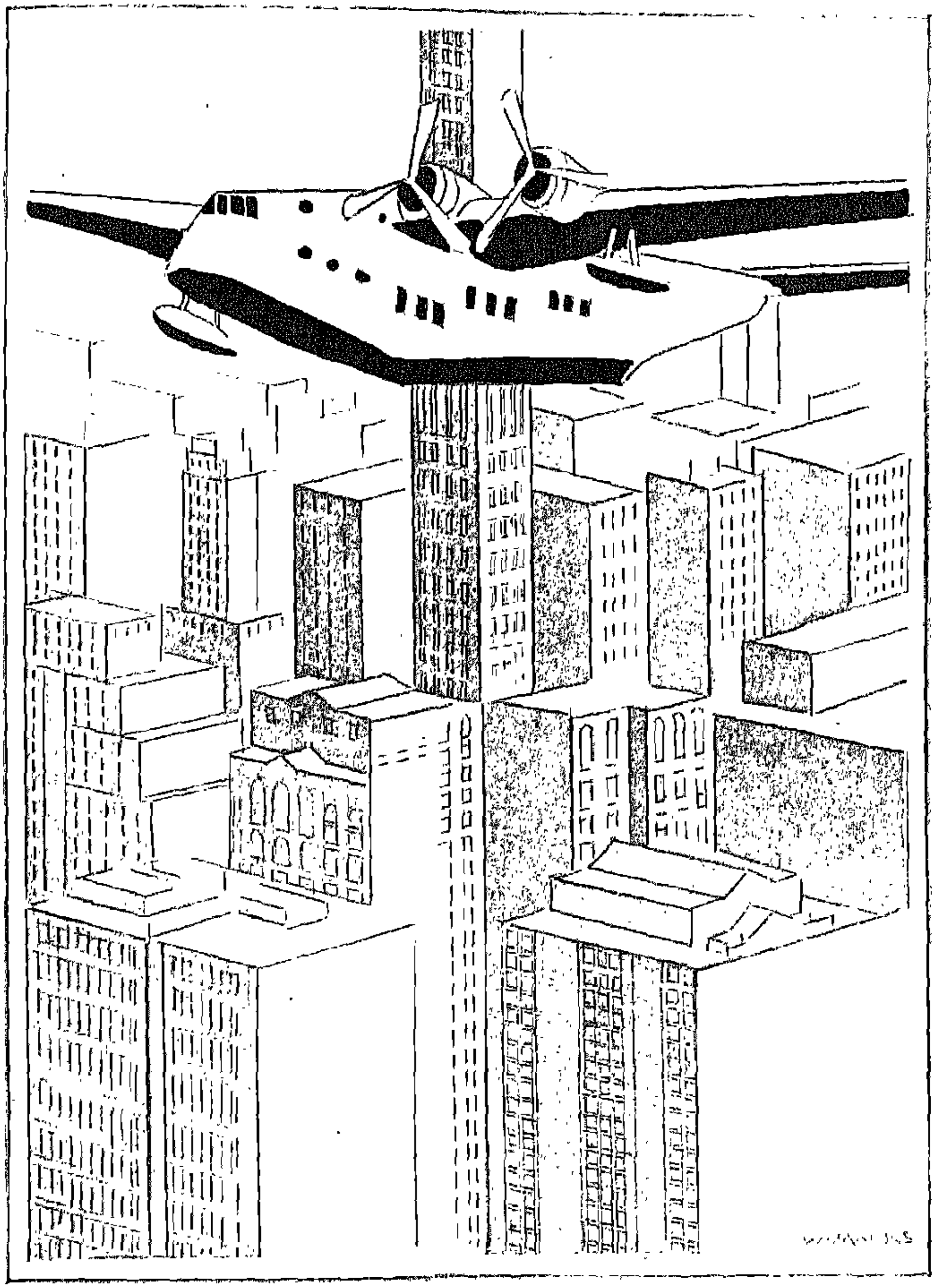


PLATE XXXIII

Composition

The composition of this Plate involved the selection and arrangement of parts to express modern mechanisation. A hard streamlined effect was aimed at, therefore the buildings and the machine are in clear, balanced lines.

PLATE XXXIV. STRENGTH AND FREEDOM

Plate XXXIV is a sketch of a part of the bridge at Burford in Oxfordshire. The water is shown by the reflection of the bridge; the road over the top is shown by the horse and cart; the solidity of the structure by giving up a large proportion of the picture to the bridge and by keeping the shadows broad and simple; the atmosphere is shown by the objects which are going over the bridge, by the quality of the tones and the presence of the willows.

I described what I saw quite directly and simply, without letting my attention wander.

I decided what lines and tones I wanted and began to work. The willow branches were drawn with easy, downward strokes. Beginning with the darkest, the tones were carefully adjusted, and each was run on with broad, wet washes.

Had I faithfully copied the scene, I should have drawn in all the stones and every line of the bark of the tree and more people and objects over the bridge, but they would have attracted the eye all over the picture. The attention would have been distracted, and the eye would not have been able to focus on one point.

If I had gone over the lines and tones several times, or split up the broad, simple tones into little accidences of light and dark, the result would not have been successful. The lines and tones could not have done their work. I should have prevented them from expressing the purpose in mind.

I thought and worked in a direct simple way like this because I was concentrating on producing a free, strong sketch.

My attention was not distracted by unnecessary incidents; it was free to express the purpose and therefore the lines and tones were used to their greatest advantage.

For these reasons, the sketch was made freely and is, therefore, strong.

Strength which is expressed by controlled thinking and easy working is not necessarily weighty or violent. The works of Michael Angelo convey a sense of great physical power. It would seem that even a violet drawn by him must have that same quality of strength and force. Pierra della Franchesca's *Nativity* in the National Gallery is free and strong, but does not express that same force or power.

Extremes of dark and light give strength. Some people naturally express themselves forcibly by these means, but exaggerated dark and dirty shades and shadows detract from their purpose.

The *purpose* is the centre round which everything should revolve.

If a poster is to attract people to a play, it must be attractive. By its subject, colour and arrangement it must call attention to those aspects of the play best calculated to attract a would-be audience. To do this, it is necessary to be able to judge the taste of the people, and also to know something of the subject matter of the play in question. The best materials for the purpose have to be chosen and used so that they convey the ideas as ably as possible.

The work of very young children who have been encouraged to draw and encouraged, moreover, to draw freely is very often remarkable for its freedom and strength, qualities which over-trained people can only admire and envy.

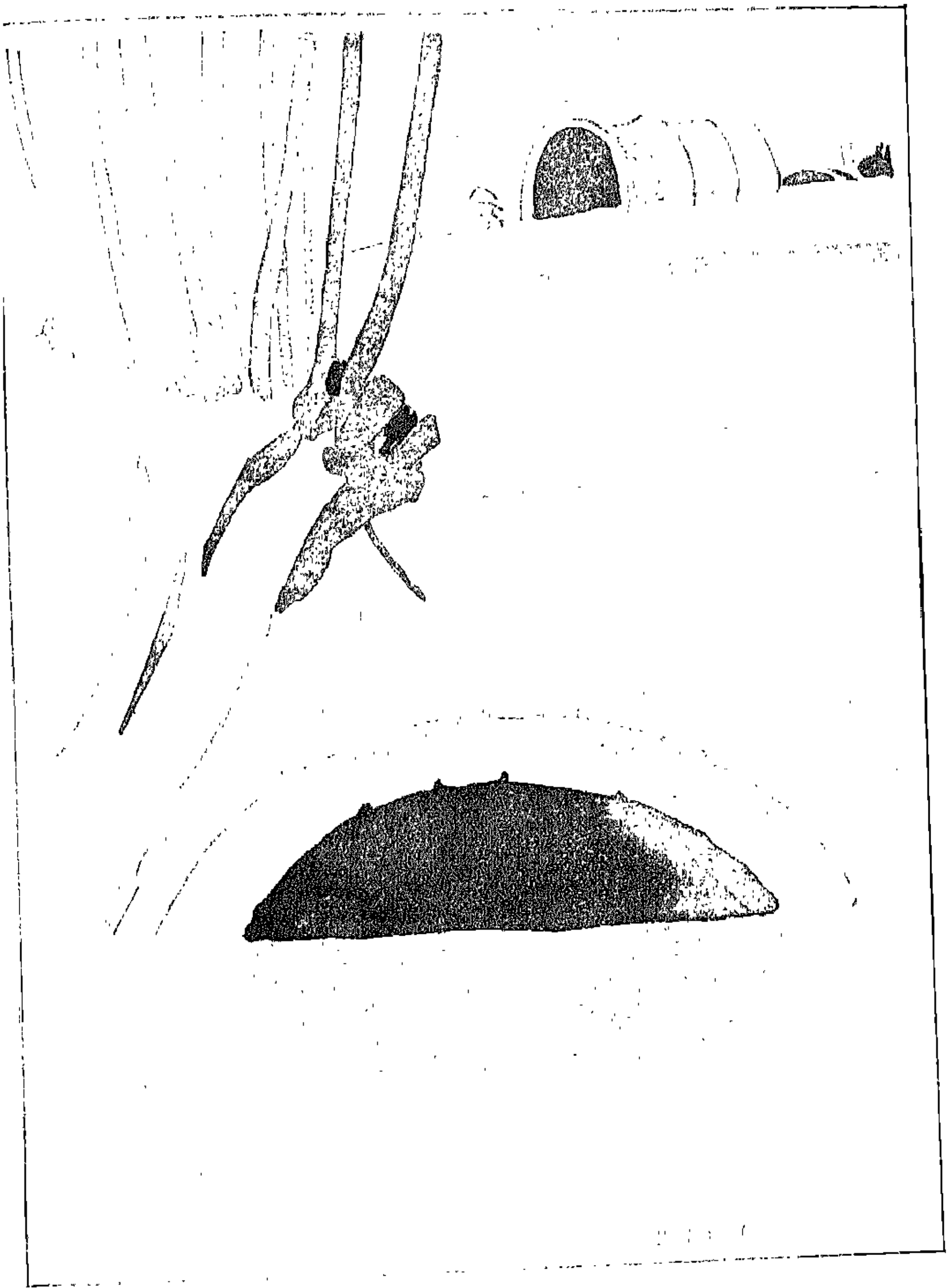


PLATE XXXIV

FREEDOM AND STRENGTH

This sketch of a bridge is expressive chiefly of strength and freedom. The eye is not detracted from the main purpose of the drawing by numerous details, but a feeling of solidity and simplicity is conveyed by breadth of treatment.

PLATE XXXV. THINGS TO LOOK FOR

Plate XXXV shows a lambing pen on the Downs and the distant country in the sunlight. It will be seen that in the particular light in which the sketch was made, the sky appeared darker in tone than many parts of the fields and objects below—darker than the top of the water cart and the straw on the pens.

Before a heavy summer storm, the rounded forms of tops of trees often appear vivid pale green in colour, and very obviously much lighter in tone than the dark grey sky against which they are seen.

It is not generally realised how often the sky, which is always thought of as light, appears darker in tone than many of the objects below. After a snow storm, the sky frequently appears darker than the roofs of the houses, and the walls of houses appear rather warm and dark in tone against the surrounding white ground.

The study of colour calls attention to subtle and attractive effects of light.

Look at the lights which are reflected from any shiny surfaced object. Move to another position. Those lights have vanished, and others are reflected.

Take some pieces of paper of different colour. Turn them slowly towards and away from the light. Examine them from different angles and different positions. Fold some into small blocks to represent houses and group them with differently coloured backgrounds and foregrounds. Arrange them in sunlight and then in a less bright light and turn them about so that the surfaces can catch and reflect the light from different angles.

They will give various interesting effects. By using various papers and trying to arrange them so that they give certain colours and tones, by thinking which colours were used, how they were associated and how they received and reflected the light, it is possible to understand why things appear as they do.

Pigments are like most materials. They produce colour by their ability to reflect certain rays of light.

These experiments will show that the choice and arrangement of colours in painting or in any other craft is a subtle and most fascinating work.

They will show how to set about making a choice and arrangement of colours for rooms and other things to give more light and more pleasant colour.

The search after colour and proportion also draws attention to a great many things which might otherwise be missed or passed over rather cursorily—the tiny village shop with its windows carefully arranged, crammed with every gorgeously coloured thing a child might wish for; the grey and yellow and green and brown of the willow leaves which have drifted into the backwater and blown into patterns by the wind; the eye of the water rat peeping out of the river bank; the quality of the colour in the spring sunlight. Shabbiness and dirt appear impossible.

Drawing is a means of communication, but its practice encourages observation and reflection and can lead to the discovery of principles which give order and beauty.

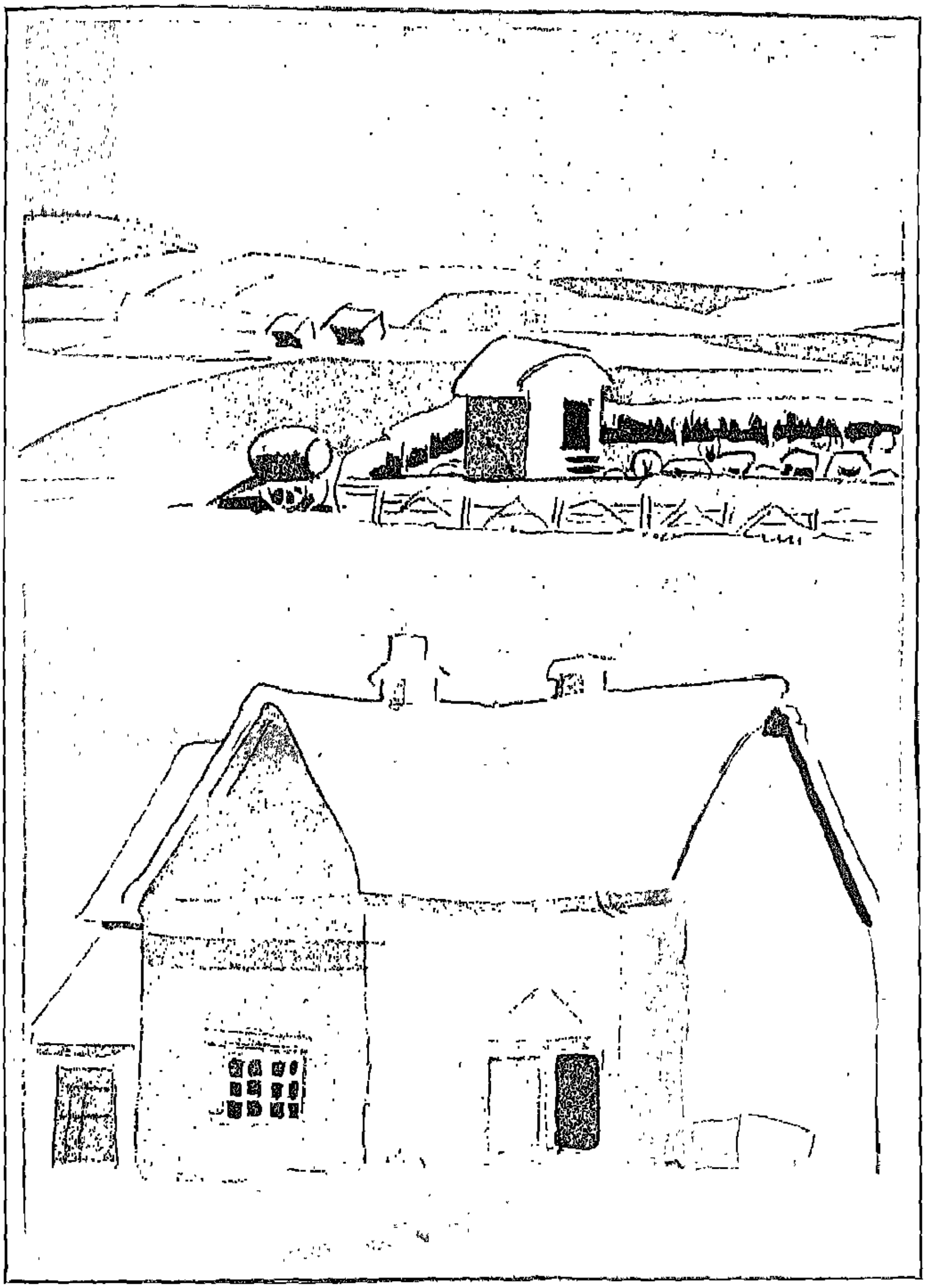


PLATE XXXV

THINGS TO LOOK FOR

Drawing awakens the critical faculties as well as the power of observation. New beauty is discovered in ordinary everyday objects while unexpected effects of colour and shading will be found in hitherto dull, uninteresting scenes.

PLATE XXXVI. THE ORIGIN OF OUR ALPHABET

Writing is a branch of drawing. The earliest kind of writing was ideographic, in picture form, scratched or cut, or painted on any material at hand.

In time, symbols—such as horns to represent a bull, a circle and dot to represent an eye—standing for syllables or sounds were put together to express things which were difficult to picture.

Gradually a particular symbol was used to represent a small number of separate sounds, and by combining these symbols any word could be written.

These symbols went through changes and were the source of various alphabets. Our alphabet was brought to perfection by the Romans in their dedicatory inscriptions on triumphal arches, pillars of victory and other structures.

It is marvellous to think that we have to learn only twenty-six simple symbols to be able to write and read. It is thought that they may have developed under the influence of writing done with a flat-ended brush. Each letter has its own proportion and character and a quality and beauty which is remarkable.

A photograph of the Roman letters from Trajan's column can be obtained from the Victoria and Albert museum. If the letters *O* and *I* only are copied, the character of their actual forms can be realised. (See Class Pictures Nos. 107 and 108.)

Plate XXXVI shows the proportions of these letters in skeleton form. All capital letters should keep these proportions, although the tool which is used to make them may modify the character slightly.

In printing and writing they are made wider and narrower frequently. Such changes are not the result of using a different tool but an alteration in proportion which makes the letters, when taken as whole, less legible and far less beautiful.

The letters *A*, *H*, *K*, *N*, *T*, *U*, *V*, *X*, *Y*, *Z* are all about three-quarters of a square in width. The bar of *A* and the points at which the top arm of *K* meets the vertical are very slightly below the half line. The bar of *H* is a little above the half line. The curve of *U* is part of a circle.

E, *F*, *J*, *L*, *P*, *R*, *S*, *B* are about half a square in width. The bar of *E*, *F* and *B* and the curve of *P* are about level with the bar of *H*. The bar of *R* is about level with the bar of A. The curves of *P*, *R* and *B* and the top and lower parts of the curve of *S* and the curve of *J* are circular.

O and *Q* are circular letters. The curves of *C*, *D* and *G* are circular. *M* and *W* are slightly wider than a square.

The quick writing of the people modified these forms and a small hand gradually evolved, which the scribes in time developed into beautiful round hands, the differences in their characters being caused by the way in which the pen was cut and held.

Gradually the use of an easily held pen and the desire to economise in time and space led to squeezing the letters and changing the beautiful proportions of the small round hands into pointed Gothic characters, which are far less legible and beautiful than the earlier round hand.

When printing was invented in different countries, with the exception of the Italians, printers modelled their types on the prevailing hand which produced the heavy angular black letter type.

In the Renaissance the professional writers of Italy reformed their writing by studying the earlier round hands. Italian printers followed the scribes and modelled a clear round type now known as the Roman small letter which is used generally in printing.

Plate XXXVII shows skeleton forms of these letters with some modifications.

Bibliography: *Writing, Illuminating and Lettering* by Edward Johnston.

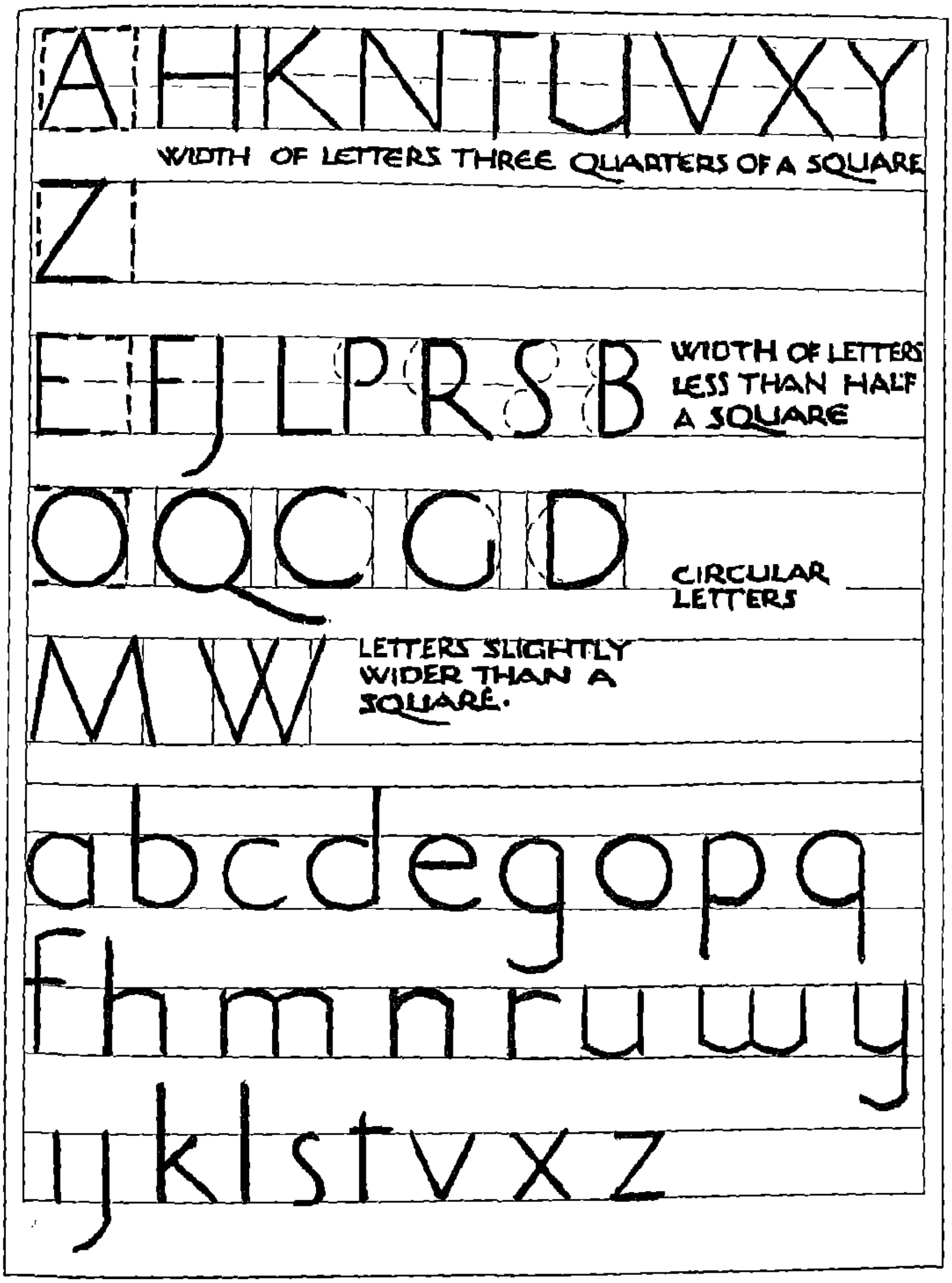

A H K N T U V X Y
WIDTH OF LETTERS THREE QUARTERS OF A SQUARE
Z
E F J L P R S B
WIDTH OF LETTERS LESS THAN HALF A SQUARE
O Q C G D
CIRCULAR LETTERS
M W
LETTERS SLIGHTLY WIDER THAN A SQUARE.
a b c d e g o p q
f h m n r u w y
i j k l s t v x z

PLATE XXXVI

Skeleton Forms of Roman Capitals and Roman Small Letters

Writing is one branch of drawing. The growth of our alphabet, dating from the earliest times when little pictures were used to represent certain sounds, is a most interesting study.

PLATE XXXVII. THE ESSENTIAL FORMS OF THE ALPHABET

It is necessary to know the proportions of the Roman capitals and how to use them. Variations considered at the time of little importance can easily be taken into general use.

The letters can be ruled with a round-ended lettering brush or a soft pencil on sectional ruled paper. This type of paper guides the brush or pencil and is very helpful. Brush lettering can be done in water colour, vermilion and viridien being used as well as black. The brush is used with plenty of colour, and with direct strokes.

Lettering is an exacting craft. The eye and hand tire very quickly. It is better to learn three or four letters only at a time and to draw one or two words with those letters. Those in the group with *A* are easy to begin with.

Each letter is built up with certain strokes. If the letters are discussed, they are understood before they are drawn. For instance, the letter *O* is begun on the left. The brush curves down and then to the right and slightly up. It is taken off, and picks up the curve at the top, draws slightly upwards to the right and downwards to complete the circle. Vertical strokes should begin and end firmly and must always be kept upright. Horizontal strokes are drawn with a horizontal brush.

The numerous monumental inscriptions all show what a beautiful quality can be gained in Roman lettering, and every letter should be drawn with pleasure and with a desire to make it as well as possible. The circular letters perhaps more than the others give it its fine character, and great care should be taken to keep them quite circular.

When drawing a word each letter is drawn as closely as possible to the one before, though not too close to spoil its character. When, however, vertical strokes come together as in *the* and *will* in Plate XXXVII they are arranged sufficiently far apart to give an even effect of line and space.

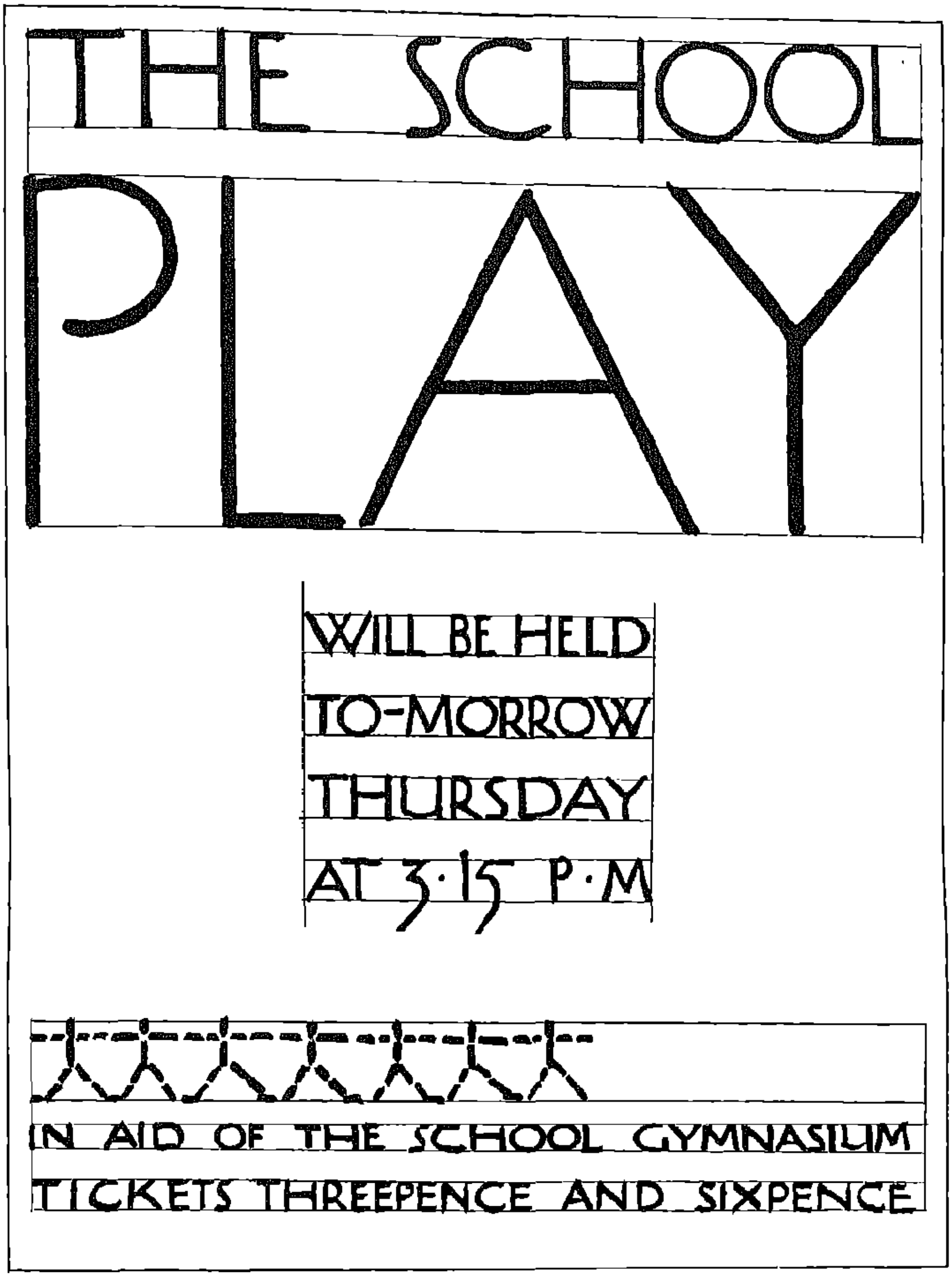
When writing a sentence, about the width of a circle is left between each word.

When the proportions of the letters are realised, two short lines of lettering can be done. The space between the lines can be equal to the height of the letters. The words of the sentence are chosen so that they will fit into the given rectangular block. Some letters are less beautiful and more difficult to draw than others and can be avoided.

The words should be arranged very lightly in pencil, and the letters moved and adjusted willingly until they are composed pleasantly in the given space. Letters and spaces may have to be made slightly larger or slightly smaller than they should be to make them fit. This appears a contradiction to the statement that the proportions of letters should not be changed, but the art of spacing is in making these adjustments so skilfully that they are not seen.

Notices may be more attractive at times on coloured paper, but they should be spaced out on rough paper first to discover which are the important words to emphasise and what is the most simple and clear arrangement.

The arrangement of lines and spaces in lettering is one of the most exacting experiences in proportion, and one of the most pleasant, but for some children it is far too exacting and it tires the eyes too much. Also, definite harm is done if the letters are not accurately drawn.



THE SCHOOL

PLAY

WILL BE HELD

TO-MORROW

THURSDAY

AT 3·15 P·M

IN AID OF THE SCHOOL GYMNASIUM

TICKETS THREEPENCE AND SIXPENCE

PLATE XXXVII

THE USE OF SKELETON LETTERS

This Plate shows how to arrange a notice in lettering. The important word or words have to be brought out clearly in the arrangement, while the whole must give a neat, business-like appearance. The correct proportions of the letters should be kept.

PLATE XXXVIII. THE USE OF A MANUSCRIPT PEN

Plates XXXVIII, XXXIX and XL are written to show how to use a pen and how to build up letters. When the pen is understood, if it is desired, a style can be modelled on one of the beautiful early manuscripts. Harl. M. S. 2904 in the British Museum shows some particularly satisfying tenth century writing.

A chisel-ended pen is one of the tools which shows clearly that materials and tools have their work to do, and that their nature has to be understood if they are to be used rightly and with the most pleasing effect.

A smooth surfaced paper is used for lettering. A sectional, ruled paper is very helpful in learning how to use the pen. Manuscript ink is kept carefully corked when not in use. Dry, thick ink is useless. Black shows faults most clearly, but for change and interest vermilion and viridien can be used also. Separate pens are kept for each colour.

It is best to begin writing with a nib which is broad enough to make and explain the strokes easily and clearly. The reservoir is placed as in a fountain pen. It must hold firmly and not be allowed to slip about. If it presses against the nib, it prevents the ink from flowing; if it is too far from the nib, it draws the ink away in a blob, which presently falls on the paper. The pen is dipped into the ink, and the top of the nib cleaned with a piece of linen rag.

The drawing board is kept at an angle of about 45° to the table. If two or more sheets of blotting paper are placed under the writing paper, the pen runs more easily. The paper is supported by pins, but *not* pinned. It is best to write at the same level moving the paper up after writing about two lines.

Plates XXXVIII, XXXIX, and XL are written with a steel nib with the edge at right angles to the shaft. This is placed and kept at 45° to the margin all the time the writing is being done, and it must have perfect contact with the paper. The shaft of the pen lies in a diagonal position and is held so that it slopes very slightly towards the paper to allow the ink to flow down gradually. The pen is not turned about at all; it might be considered as fixed in the hand. All the writer has to consider is the direction in which the hand is to go.

If the pen is placed in position and drawn forward in a line with the shaft, it gives the broadest stroke. If it is drawn forward in a line with the edge of the nib, it gives its thinnest stroke, which is at right angles to the broad stroke. When it is drawn down the vertical line, it gives the stroke which is intermediate in width. After filling and cleaning the pen, it is tried on a scrap of rough paper to see if the ink is flowing rightly.

Two or three repeats of a border can be done first. The broad strokes must be the broadest and parallel to each other. The thin strokes must be thin lines at right angles to the broad strokes and parallel to each other.

Three or four easily constructed letters can be analysed and built up first, and then a word can be written with those letters. Edward Johnston gives the width of *O* approximately five times, and the height approximately four times the width of the thickest stroke.

Taking the letter *C*, it is made up of two strokes; the first takes three directions, the second only one. If they are drawn in the squared form first separately, and then together to make the letter, these directions are easily understood. When the strokes are drawn in the rounded form, the curve begins before the angle is made. When writing the pen is steady, the hand draws easily and the concentration is on the essential form of the letters, which with slight exceptions are based on the skeleton forms in Plate XXXVI.

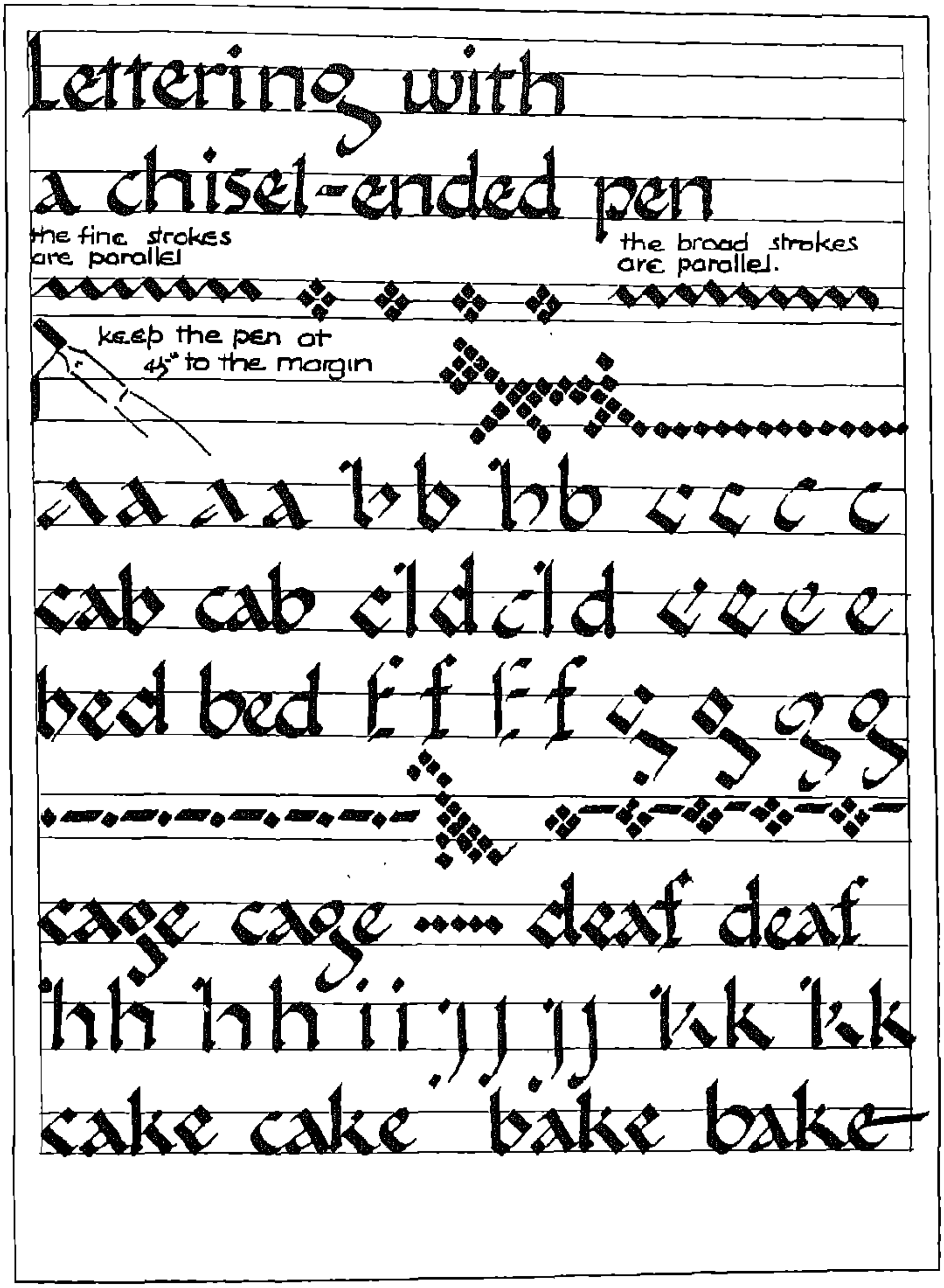

Lettering with
a chisel-ended pen
the fine strokes are parallel
the broad strokes are parallel.
keep the pen at 45° to the margin
aa aa bb bb cccc
cab cab cldcld eeee
bed bed ff ff gggg
cage cage deaf deaf
hh hh ii jj jj kk kk
cake cake bake bake

PLATE XXXVIII

LETTERING WITH A CHISEL-ENDED PEN

This Plate shows how to learn the use of a chisel-ended pen and the strokes with which the first eleven letters of the alphabet can be built up.

PLATE XXXIX. THE STORY OF WRITING—1

In the illustration Plate XXXIX is a beautiful drawing of a reindeer carved on a piece of antler by one of the ancient cave men. It was found near Thayngen, Switzerland, and is an example of an art that proceeded no farther and became lost to the world.

In the very early days man had to rely solely upon speech and memory if he wished to tell his friends of important happenings.

As life became less simple and tribes came in contact with one another a sign language began to grow, a sort of writing in the air with the hands, in order to express emotions, actions and commands. The next step came when messages had to be sent a distance away. Messengers were not always reliable and, in consequence, various ideas came into use.

The message stick, still to be seen in Western Australia, was among the earliest and was not so much a message in itself as a reminder for the carrier, who told his story and referred to his stick to make sure that nothing had been omitted. Such sticks were also in use among the ancient peoples of China and America and, many years after, the notched sticks, the account book and bills of the Serbians, and the tally sticks and clogg almanacs of the Englishman of the Middle Ages, were in constant use.

Another idea was the knotted cord, used by the Chinese, Persians, Mexicans and particularly the Peruvians, who called it the quipu. At first the knots merely indicated numbers, a single knot meaning 10, a double one 100, two knots side by side 20, and so on, but soon a deeper significance developed. A knot close to the stick meant important news; a black knot, death; and a white knot, peace or silver.

The American Indians used coloured shells for a similar purpose, and long messages could be carried on strings made into a many coloured belt or wampum.

Sometimes actual things were sent in order to express a meaning. To the Scythians a frog meant, "Can you leap like a frog through the swamps?" A mouse meant, "Can you hide in the earth like a mouse?" And to the Indians a pipe signified peace; a spear or arrow, war; and a drawn bow, attack. This was all very well for short messages, but a long one would probably need quite a number of very awkward things to be carried, so consequently in many parts of the world man made use of his ability to draw pictures. When it came to portraying abstract things, he drew certain objects that always conveyed a special meaning. Thus the turtle, the luck bringer, signified happiness; bravery was represented by a lion or an eagle; and a snake, which lived for ever, according to the current belief, was a symbol for life.

The ancient rock inscription, as shown, is a picture story that was found on a cliff near Lake Superior in North America. Five war canoes are drawn, containing fifty-one braves, the first boat being led by the Kingfisher, whose totem or family sign is seen above. Apparently, they set out on an expedition lasting three days, three suns under the arches of the sky, with their magic maker, the man on horseback, to bring success. The turtle shows that the foray was successful, owing to the bravery, indicated by the eagle, of the Indians. Whether the meaning of the curious creatures at the bottom is a panther, the totem of the chief, or a snake, to show that no one was killed; or whether they are animal spirits invited to aid the expedition, is rather obscure.

The ancient Mexicans went much farther than these drawings and developed the rebus, a method of indicating a word by its sound and not merely by its form. One further relic of man's efforts with crude pictures before passing to the stages of a higher civilisation is seen in the *Totem Pole*, allied to pictures on tombstones and tattooing on the body, to indicate certain features of the clan or family of an individual. They were erected in front of dwelling places and were found in British Columbia, Central America and New Zealand, the totem itself becoming the autograph of a chief and used as his signature in dealings with other people. The one in the picture, from Queen Charlotte Island, is 38 ft. high and is now to be seen in the British Museum.

Archaic hieroglyphs.—Pictures lead to hieroglyphics, the curious shapes and drawings that cover the walls of ancient Egyptian temples and pyramids. Until the 19th century they were a complete mystery to the modern world and it was only after the lucky discovery at Rosetti of a huge, flat stone with letters inscribed in two languages, together with a further find of an obelisk on the island of Phile, that the French scholar, Champollion, was able to announce the solution of the puzzle. He discovered that the Egyptians had advanced from mere pictures to shapes that represented sometimes words, sometimes syllables and sometimes letters, and often picture and shape were placed side by side to make the meaning clear.

The archaic hieroglyphics seen in the picture come from what is known as the Father Schid tablet, a relic of probably the earliest form of lettering before use had begun to make the outlines more simple.

Bone Ring.—In China, the land where the past lives with the present, the pictures of bygone ages are still to be seen in the writing of to-day. It is very difficult for us to decipher, as there is no alphabet and many words have each a number of meanings, but just as the Egyptians did in working out their hieroglyphics, the Chinese draw their picture, very much simplified in shape, of course, and then add others to give the full meaning. The earliest form of Chinese writing known is seen in the picture of the *Bone Ring.* This dates probably as far back as 1700 B.C. and was a badge given by the emperor to a deserving official.

The story of letters does not end with hieroglyphics. Hundreds of years passed in which they travelled at first by the way of Phoenician traders to Greece, where they stayed for 2000 years; then to Rome, then north, to Russia, and thus throughout the whole world so that there is not one alphabet to-day that has not descended from ancient Egypt.

During that time many changes took place; some of the shapes were lost, new ones were added; many were quite altered and most were turned round by the Greeks in the opposite direction. The last idea was because the writers, instead of writing from the top to the bottom, starting at the right as the ancient Egyptians did and the Chinese do now, began to write from left to right. They did this because early ink was a mixture of soot, vegetable glue and water that dried very slowly, and the scribe in coming to his second line was bound to smear his work. This change in direction naturally caused a change in the direction of the letters; it was easier and quicker to draw them that way. With regard to the Chinese, as they used quick drying Indian ink there was no need to change their original method.

With the travelling of the letters from land to land, changes in another direction took place. New materials were being sought and gradually stone gave way to papyrus, papyrus to waxen tablet, then parchment and, finally, paper.

In the earliest days Man had to make use of anything he could find on which to fashion his pictures—shoulder blades of sheep, broken pieces of pottery, bits of bark, anything that could be marked by a sharpened bone or stick. These ways lasted for many years; Mahomet is said to have written the Koran on pieces of sheeps' shoulder blades; Roman soldiers in Egypt when short of papyrus wrote on pieces of broken pottery; in India whole books were made of palm leaves and our word *ostracise* comes directly from the *ostraca* or oyster shells used as receipts by ancient tax collectors. Of all the ancient books, the stone one has naturally lived the longest, but so tedious was the task of carving and so weighty the material, that eventually the Babylonians and Assyrians discovered a better idea.

They cut tablets of clay from the banks of their rivers, wrote upon them with little

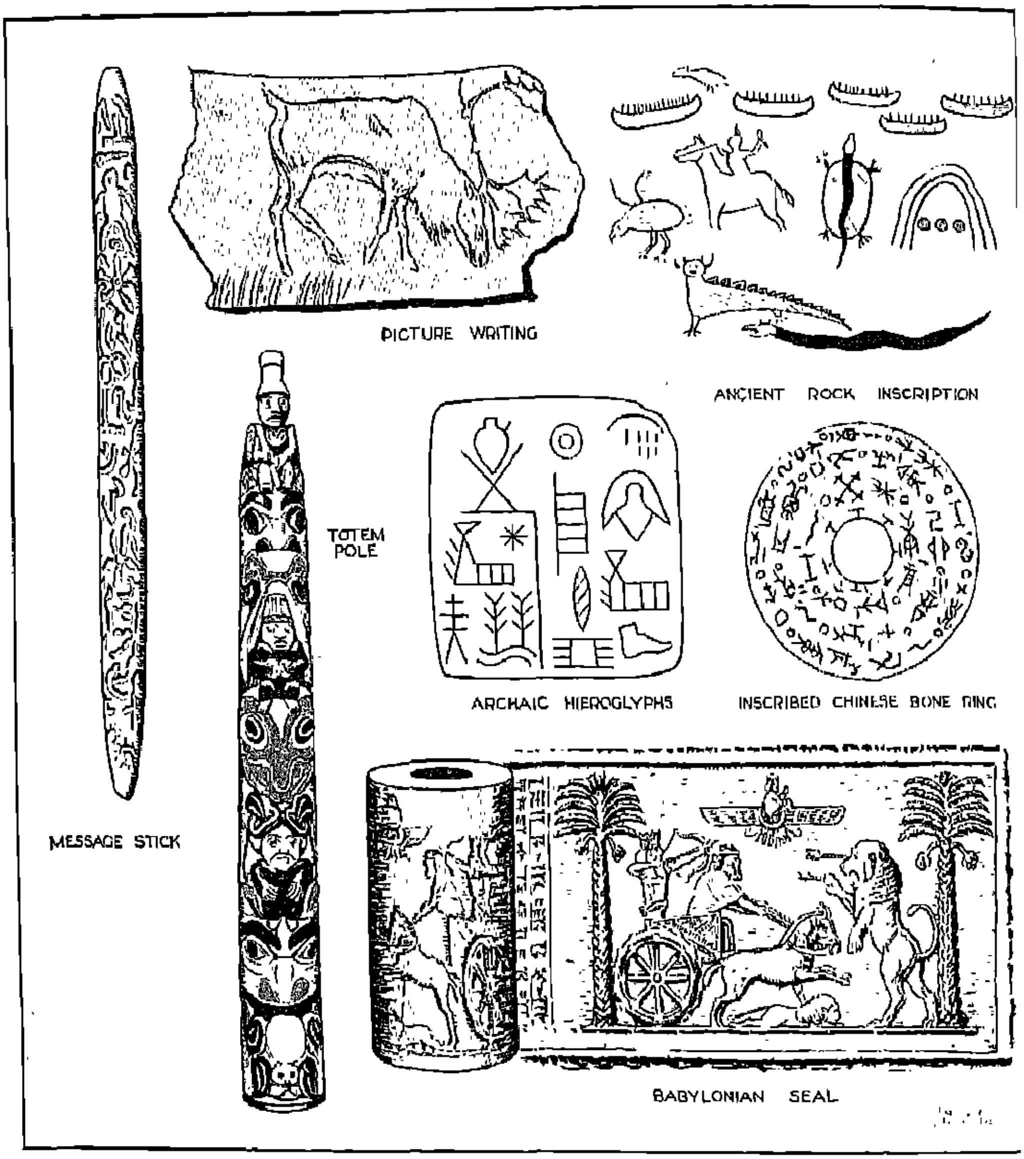


PLATE XXXIX

STORY OF WRITING—1

(Class Picture No. 73 in the portfolio.)

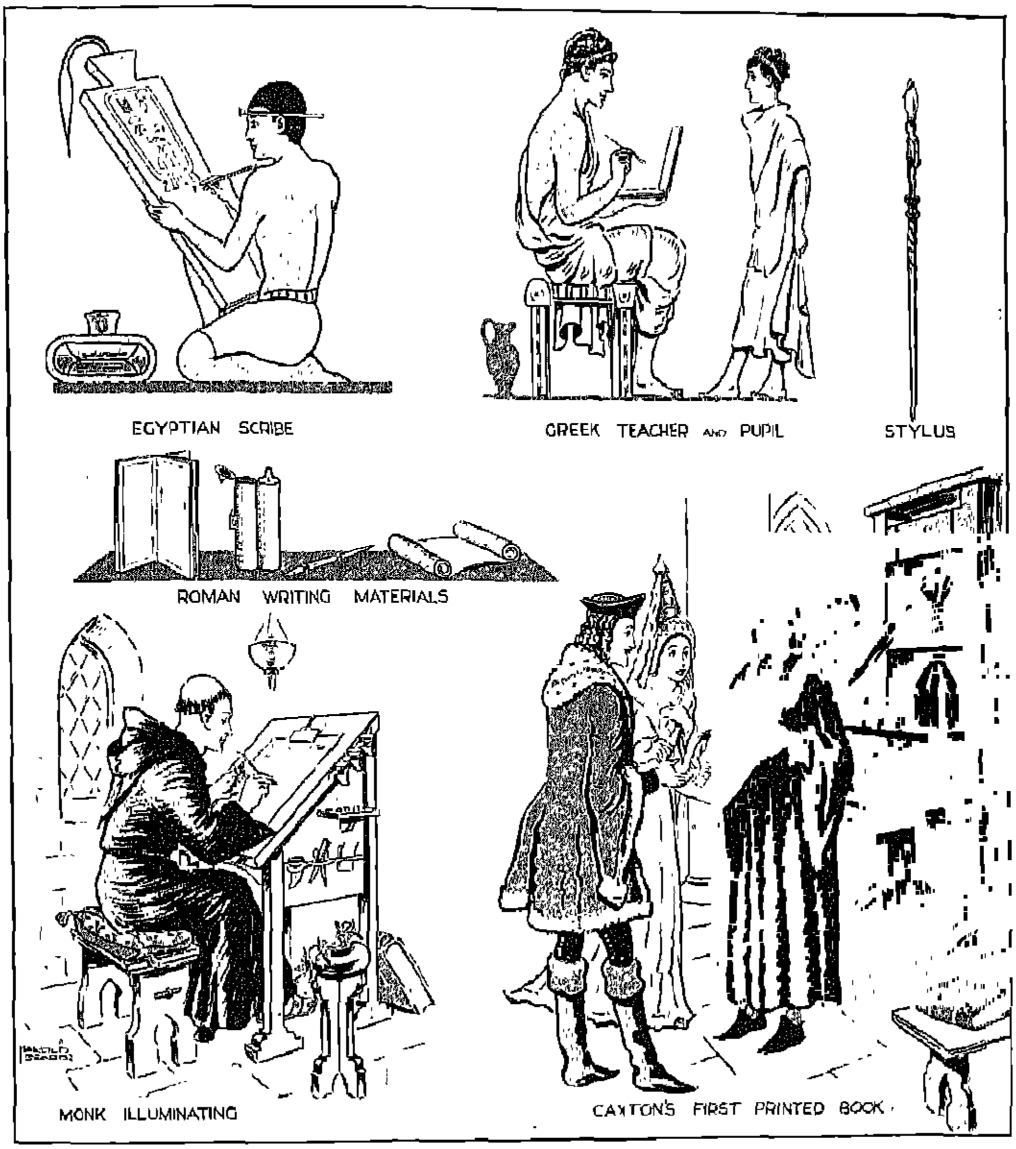


PLATE XL

STORY OF WRITING—2

(Class Picture No. 74 in the portfolio.)

three cornered sticks, and then sent them to the potter to be fired. So well have these lasted that a library of 30,000 such tablets has been unearthed at Nineveh. A number of them went to make a book and, to preserve the right order, they were all numbered with a suitable heading placed at the top of each. The books tell of wars, heroic deeds and, in one, the story of Ishtar the goddess who went down into the underworld to bring back her husband.

Babylonian seal.—Besides writing, the Assyrians, Babylonians and, later, the Egyptians, printed on clay, and in the last picture is a seal on which is inscribed in three languages the name and titles of Darius the Great, King of Persia, the design showing him hunting lions in a palm plantation. A seal was made of precious stones such as onyx, amethyst, topaz, lapis-lazuli, the design being cut with a metal graver and the deeper parts hollowed out by means of a drill. On the conclusion of a treaty or a trade agreement the seal, being made in the shape of a cylinder, could be rolled along a clay tablet and thus a permanent record was made. As the cylinder was hollow, the owner threaded it on a string as a convenient way of carrying it.

With the seal the first part of the story of writing is ended. Crude pictures have developed into definite letters. How the scores of symbols were finally shortened until the definite twenty-six of our alphabet were left is even to-day not quite clear. The Phoenicians undoubtedly possessed a definite alphabet, but whether they borrowed it from the later Egyptians or whether, as some people think, it came from the highly civilised people of the island of Crete, is still an unsolved problem.

Plate XL.—The Phoenician alphabet passed into Greece from several directions and for a time each Hellenic state developed its own, altering the original one from time to time as convenience dictated. Finally two main types were evolved, the Eastern and the Western, and these in the year 403 B.C. were reduced to one, the Ionic form. This was the classic Greek alphabet that many years later travelled into Italy and was eventually given its monumental perfection by the Romans. This is the alphabet that is the most widely spread in the world to-day, the only other one that competes with it at all in popularity being the Arabic, that is still used throughout Central Asia.

At this point it must not be forgotten that all the letters used up to the beginning of the Christian era were upright capitals. So far, the minuscule or small letter had not developed and for this it is necessary to return to the transformation in the means of writing.

The first picture (Plate XL) is that of an Egyptian scribe writing on papyrus with a reed pen. Papyrus, a great advance upon clay, was made from a water plant that grew by the river Nile. The stems were split and pasted together to form a page; then a further page was pasted on the top in an opposite direction and so on many times, the whole mass being heavily weighted and left to dry. When ready, a number of pages were glued together in a long strip and rolled round a decorated rod to prevent cracking and also for convenience in using. The ink used in writing has been mentioned before; it could be easily erased with a sponge though the scribe often had to use his tongue. There is a story that at one of the contests for the best poem, held at the court of the Emperor Caligula, all the unfortunate poets who lost were ordered to lick out their own compositions. Papyrus and ink gave much greater speed to writing and amongst ordinary people there was soon a tendency to run letters together and to curve their original straight lines. The priests still wrote carefully to preserve the beauty of the old lettering, but before long three definite styles were in vogue, the old hieroglyphics chiselled in stone, the hieratic script of the sacred scribes, and the demotic or very cursive style used in commerce.

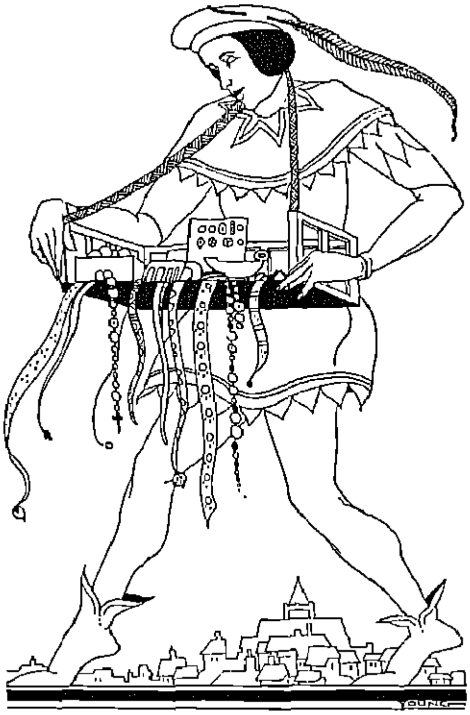
In the next series of pictures are seen the writing materials that were still employed right up to the 18th century. They were the famous *waxen tablets* of the Greeks and Romans that were used mainly for letters, business notes and in schools, and not for work that was expected to be lasting. Papyrus was expensive and often not obtainable, so tablets were prepared with hollow centres for the wax and holes punched in the two inner corners so that they could be fastened together. To write on the wax, a metal stylus took the place of a pen. It was sharp at one end, often decorative in form, and rounded at the bottom to act as an eraser. As the wax could readily be rubbed smooth, a tablet could serve many times and no schoolboy of the period was complete without one hanging at his belt.

Writing was by now a common art; there were thousands of educated Greek slaves in Rome alone, all occupied in copying books, some of which even ran to 2,000 copies to an edition. Thus some Roman scholars possessed in their libraries as many as 60,000 volumes or rolls of manuscripts. It is no wonder that by the 1st century A.D. the old Greek and Roman capitals had begun to degenerate into forms that led eventually to a complete style of writing.

The next picture shows a *monk illuminating* or decorating the words in a most beautiful manner, as he carefully pens them in his book. But now the writing is no longer on papyrus, but on parchment or pergament, the name given to it by the city of Pergamos in Asia, the place of its origin. It is said that the library of Pergamos once threatened to outdo the famous library of the city of Alexandria with its million rolls of papyrus. To check this, the ruling pharaoh at the time ordered the export of papyrus from Egypt to Asia to cease, and consequently the king of Pergamos in his turn commanded his most skilful leather workers to prepare a material from the skins of sheep and goats that would take the place of papyrus. By soaking and scraping and rubbing, this was done and the result was parchment, a beautiful yellowish material that could be varied in thickness and quality and that could be folded without cracking. When Egypt was overrun by the Arabs, the export of papyrus into Europe was stopped altogether, and in the Dark Ages to follow, when educated people became fewer and fewer and reading almost a lost art, the result of countless years of development might well have been lost to the world if it had not been for the work of the monks, chiefly of the Benedictine order. A room in the monastery, known as the scriptorium, was set apart for the daily toil of copying the scriptures and other literary productions. In it was the complete outfit of the writer—parchment; vellum from newborn lambs or kids; pumic stone for smoothing; pens made from reeds or from goose or crow feathers; black ink made from oak galls and copperas, and red ink made from red earth. Here the monks spent patient hours of toil, a whole year being passed in producing a book of five hundred pages. Each book represented many tasks; one monk split the leather, another acted as polisher and smoother, a third did the writing, a fourth the illuminating, a fifth was the artist who drew the tiny pictures, and a sixth bound the finished work into a beautiful volume. Parchment was very expensive, the monks often having to depend on the gifts of pious merchants or wandering robber knights who wished to save their souls, and consequently the utmost economy had to be practised. Letters were placed as close as possible to each other or run together, and shortened forms such as Jm. for Jerusalem were often used. Thus it can be easily seen that the uncial or large letter, after becoming rounded, diminished in size and little by little developed into the perfect miniscule as used to-day.

The last picture shows William Caxton displaying his *first printed book*, *The Dictes or sayengis of the Philosophers*, to King Edward IV in the year 1477. The art of printing followed on the progress in paper making. It may seem strange, but the Chinese 2,000 years ago made paper from bamboo, grass and old rags. The Arabs stole the secret after a war in the year 704, but it was not until the 13th century that mills for its manufacture were set up in Europe. Paper was very much cheaper than parchment and consequently all types of intelligent people, other than monks, could learn to write and enjoy the field of knowledge opened to them by Dante in his *Divina Commedia*, Petrarch and his studies of the Latin and Greek classics, and Boccaccio with his modern stories.

In the days of William the Conqueror, stamps and seals, similar to those of the Babylonians in purpose, had been fashioned by engraving on wood. These in turn gave the idea of carving on a block, a complete page of a book, so that many prints could be taken, and in the 14th and 15th centuries block books, as they were called, of religious works were quite common in Germany and Flanders. This was very laborious work, and at last separate movable letters, or type, were invented. The credit for this discovery may belong either to Johann Gutenberg, 1398 to 1468, a printer from Mainz, in Germany; or to Lourens Coster, who printed at Haärlem, Holland, between the years 1440 and 1446. Whoever it was, the great gift was given to the world, and when metal type took the place of wooden letters books were available for all who cared to understand. William Caxton, as we know, learned the trade of printing in Bruges, where he had lived for thirty years. He returned to England after the Wars of the Roses and, once he had set up a press in Westminster, it was not long before the universities of Oxford and Cambridge carried on with the work.



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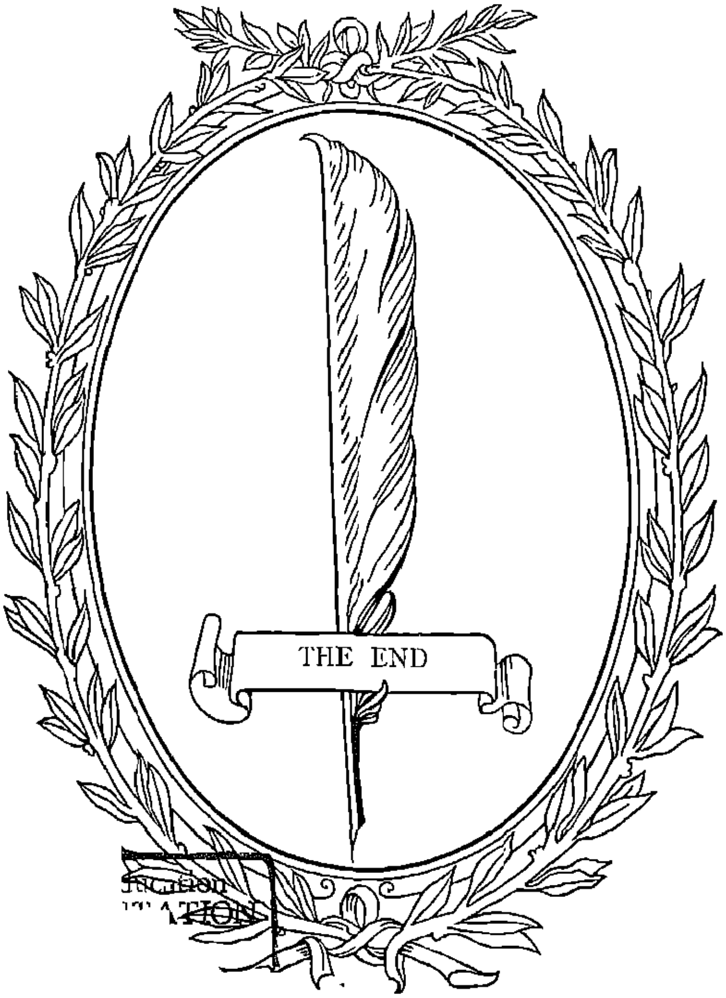

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